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A new species of *Androctonus* Ehrenberg, 1828 from Western Sahara (Scorpiones: Buthidae)

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Abstract

A new species of *Androctonus* Ehrenberg, 1828 is described on the basis of one male and one female collected in the region of Adrar Sotuf, Western Sahara. This new scorpion taxon represents the 33rd known species of the genus *Androctonus* and the 3rd reported from Western Sahara. A geographical distribution map of the *Androctonus* species occurring in Morocco and Western Sahara is presented and one taxon is raised to species rank, *Androctonus bourdoni* Vachon, 1948 stat. n.

Keywords: Scorpion, *Androctonus agrab* sp. n., *Androctonus bourdoni* stat. n., *Androctonus mauritanicus*, taxonomy, new species, description, morphology, Western Sahara, Morocco.

Introduction

As already outlined in several papers (Lourenço, 2005; Lourenço & Qi, 2006, 2007; Lourenço, 2008; Ythier, 2021) the taxonomy of the genus *Androctonus* Ehrenberg has long remained confused. In his work on scorpions from northern Africa, Vachon (1948, 1952) attempted to establish a better definition of the genus *Androctonus* and its species. However, the classification proposed by Vachon remained unsatisfactory, mainly because of the existence of several poorly defined subspecies, some of them even being described for populations totally disconnected geographically. An example is provided by *Androctonus crassicauda* (Olivier, 1807) which is distributed in the Middle East, and the

subspecies *Androctonus crassicauda gonneti* Vachon, 1948 distributed in Morocco, Western Sahara and Mauritania. Lourenço (2005) characterized both populations as distinct and raised *A. gonneti* to the rank of species. Another example is *Androctonus liouvillei* (Pallary, 1924), distributed in eastern Morocco up to northwestern Algeria (see Fig. 20). This species was originally described as *Buthus* (*Prionurus*) *liouvillei* and considered by Vachon (1948, 1952) to be a subspecies of *Androctonus aeneas* C.L. Koch, 1839, distributed from northwestern Algeria up to Tunisia (Lourenço, Rossi & Sadine, 2015). Lourenço (2005) reconsidered the taxonomic position of this subspecies and raised *Androctonus liouvillei* to the rank of species. In the present study, we also reconsider the taxonomy of *Androctonus bourdoni* Vachon, 1948 stat. n., originally described from southern Morocco (Souss Valley) as a subspecies of *Androctonus mauritanicus* (Pocock, 1902) (described from Northern Morocco and distributed up to the Souss Valley; see Fig. 21) then placed in synonymy of *A. mauritanicus* (Lourenço, 2005). Examination of additional specimens led us to elevate *A. bourdoni* stat. n. to species status, based on morphological features and distribution. The revision carried out by Lourenço (2005) on the genus *Androctonus*, as well as other studies conducted in the deserts of southern Morocco, Western Sahara and Mauritania, tend to show that this particular area contains a very diverse fauna of scorpions, including several new species and even new genera (Lourenço, 2002a,b; Lourenço & Duhem, 2009). Recent discovery in the collections of the MNHN (Muséum national d'Histoire naturelle, Paris, France) of two specimens collected in the 1960s by the late Prof. Pierre Louis Dekeyser in the region of Adrar-Sotuf, Western Sahara, has led to the description of another new species of *Androctonus*. The new species described here represents the 33rd known species of the genus *Androctonus* and the 3rd reported from Western Sahara.

Methods

Illustrations and measurements were made with the aid of a Wild M5 stereo-microscope with a drawing tube (camera lucida) and an ocular micrometre. Map was made using Adobe Photoshop software. Measurements follow Stahnke (1970) and are given in mm. Trichobothrial notations follow Vachon (1974) and morphological terminology mostly follows Vachon (1952) and Hjelle (1990). Specimens studied herein are deposited in the MNHN (Muséum national d'Histoire naturelle), Paris, France and EYCP (Eric Ythier Private Collection, Romanèche-Thorins, France).

Composition of the genus *Androctonus* (in order of description)

- *Androctonus australis* (Linnaeus, 1758) (Algeria, Egypt, Libya, Morocco, Tunisia)
- *Androctonus crassicauda* (Olivier, 1807) (Armenia, Azerbaijan, Bahrain, Egypt, Iraq, Iran, Israel, Jordan, Kuwait, Libya, Oman, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen)
- *Androctonus amoreuxi* (Audouin, 1825) (Algeria, Libya, Egypt, Mauritania, Morocco, Western Sahara, Israel?)
- *Androctonus bicolor* Ehrenberg, 1828 (Egypt, Israel, Libya, Syria, Jordan?, Lebanon?)
- *Androctonus aeneas* C.L. Koch, 1839 (Algeria, Tunisia)
- *Androctonus finitimus* (Pocock, 1897) (Pakistan)
- *Androctonus baluchicus* (Pocock, 1900) (Afghanistan, Pakistan)
- *Androctonus mauritanicus* (Pocock, 1902) (Morocco)
- *Androctonus liouvillei* (Pallary, 1924) (Algeria, Morocco)
- *Androctonus eburneus* (Pallary, 1928) (Algeria)
- *Androctonus hoggarensis* (Pallary, 1929) (Algeria)

- *Androctonus barbouri* (Werner, 1932) (Morocco)
- *Androctonus bourdoni* Vachon, 1948 stat. n. (Morocco) *
- *Androctonus gonneti* Vachon, 1948 (Mauritania, Morocco, Western Sahara)
- *Androctonus sergenti* Vachon, 1948 (Morocco)
- *Androctonus dekeyseri* Lourenço, 2005 (Mauritania, Senegal)
- *Androctonus maelfaiti* Lourenço, 2005 (India)
- *Androctonus afghanus* Lourenço & Qi, 2006 (Afghanistan)
- *Androctonus aleksandrplotkini* Lourenço & Qi, 2007 (Mauritania)
- *Androctonus togolensis* Lourenço, 2008 (Togo)
- *Androctonus maroccanus* Lourenço, Ythier & Leguin, 2009 (Morocco)
- *Androctonus pallidus* Lourenço, Duhem & Cloudsley-Thompson, 2012 (Chad)
- *Androctonus cholistanus* Kovařík & Ahmed, 2013 (India, Pakistan)
- *Androctonus robustus* Kovařík & Ahmed, 2013 (Pakistan)
- *Androctonus tenuissimus* Teruel, Kovařík & Turiel, 2013 (Egypt)
- *Androctonus donairei* Rossi, 2015 (Morocco)
- *Androctonus santi* Lourenço, 2015 (Niger)
- *Androctonus simonettai* Rossi, 2015 (Ethiopia)
- *Androctonus tigrai* Lourenço, Rossi & Sadine, 2015 (Ethiopia)
- *Androctonus tropeai* Rossi, 2015 (Pakistan)
- *Androctonus burkinensis* Ythier, 2021 (Burkina Faso)
- *Androctonus turkiyensis* Yağmur, 2021 (Turkey)
- *Androctonus agrab* sp. n. Ythier & Lourenço, 2021 (Western Sahara) *

(* = in this work)

Figs. 1-2. *Androctonus mauritanicus*, adult ♂ topotype, habitus. 1. dorsal aspect. 2. ventral aspect. (Scale bar: 1 cm).

Taxonomic treatment

Family Buthidae C.L. Koch, 1837
Genus *Androctonus* Ehrenberg, 1828

Androctonus mauritanicus (Pocock, 1902) (Figs. 1-2, 16-17; Table 1)
Buthus mauritanicus Pocock, 1902: 373.
Morocco, Tangier, Mehedija (=Mehdya).

Diagnosis (emended). Scorpion of large size for the genus, with a total length of 70-90 mm. General colouration brown to blackish-brown; carinae are generally darker, almost blackish. Carinae and granulations on carapace and tergites moderately developed. Sternite VII with four well-marked carinae. Metasomal segments I to V moderately to strongly enlarged distally; dorsal depression on segments I to IV strongly marked. Lateral carinae covering 1/4 to 1/3 of the metasomal segment II and composed of only 1-3 distal granules on the segment III. Anal arc with three rounded lobes. Pedipalps with a conspicuous setation on femur, patella and chela; chela fixed and movable fingers with 13-16 rows of granules; fixed finger of the male forming a conspicuous scalloping on the proximal dentate margin. Pectines with 25-30 teeth in males and 20-24 in females. Trichobothrium **db** of chela fixed finger basal to **est** in male and female.

Androctonus bourdoni Vachon, 1948 stat. n. (Figs. 3-4, 18-19; Table 1)
Androctonus mauritanicus bourdoni Vachon, 1948: 313.
Morocco, Agadir, Tanfigoult (=Tafingoult), Bou Izakarne (=Bouizakarne).

During more than ten years, Max Vachon developed studies on the scorpions of northern Africa which were finally concluded in 1952 with the publication of his major monograph (Vachon, 1952). During these studies, Vachon described an important number of new taxa, and in particular several new subspecies and varieties (summarized in Vachon, 1952). For the description of these new taxa, Vachon referred to a number of specimens without however any indication of precise types. It is important to understand that Vachon, as other scorpiologists before him, was not fully aware of the importance of indicating precise types. For subsequent studies it became rather complicated to locate many of these specimens. For a good number, these were integrated in the collections of the MNHN in Paris, but without the indication of types. In other cases, the material probably remained in the collections of local institutions in northern Africa and could no longer be located.

One of the subspecies described by Vachon in 1948 and which interests the present study is *Androctonus mauritanicus bourdoni* Vachon, 1948, described from the South of Morocco, in the Souss Valley (Agadir, Tafingoult, Bouizakarne). For this subspecies Vachon (1948, 1952) listed a number of adults and juveniles without any indication of types. Curiously, in the Catalog of the Scorpions of the World, Fet & Lowe (2000) indicated for this subspecies the same material already listed by Vachon (1948, 1952), but also with the precisions of syntypes (for two specimens measured by Vachon) and paratypes (for all other specimens listed by Vachon).

During this study, we were able to locate one vial in the collections of the MNHN, including two specimens, one adult male and one subadult male, from Agadir ("under stones, in a *Euphorbia* field along the seashore, in the north of the port") and with a small label written by Vachon's hands with the indication "♂ type" (see Figs. 3-4). At present it seems useful to indicate one of these specimens as lectotype (adult male) and the second as paralectotype (subadult male).

Figs. 3-4. *Androctonus bourdoni* stat. n., adult ♂ lectotype, habitus. 3. dorsal aspect. 4. ventral aspect (part of pigmentation was lost under the effect of light exposure). (Scale bar: 1 cm). Original labels included in the vial are also presented.

In this study, we also reconsider the taxonomy of *Androctonus mauritanicus bourdoni* based on morphological features after examination of additional specimens, as well as considering its distribution. *Androctonus bourdoni* Vachon, 1948 stat. n., previously in the synonymy of *Androctonus mauritanicus*, is elevated to species status herein.

Diagnosis (emended). Scorpion of medium size for the genus, with a total length of 60-70 mm. General colouration brown to blackish-brown; carinae are generally darker, almost blackish. Carinae and granulations on carapace and tergites moderately developed. Sternite VII with four well-marked carinae. Metasomal segments I to V moderately enlarged distally; dorsal depression on segments I to IV moderately to strongly marked. Lateral carinae covering half to 2/3 of the metasomal segment II and composed of 5-6 granules covering 1/4 to 1/3 of the segment III. Anal arc with three rounded lobes. Pedipalps with a moderately marked setation on femur, patella and chela; chela fixed and movable fingers with 14-15 rows of granules; fixed finger of the male forming a weakly to moderately marked scalloping on the proximal dentate margin. Pectines with 27-29 teeth in males and 23-25 in females. Trichobothrium **db** of chela fixed finger at the same level of **est** or distal to **est** in male, basal to **est** in female.

Androctonus agrab sp. n. (Figs. 5-15, Table 1)
Western Sahara, region of Adrar-Sotuf, 410 m alt., P.L. Dekeyser coll., 30/V/1964, 1♂ holotype, 1 subadult ♀ paratype. Deposited in the collection of the Muséum national d'Histoire naturelle, Paris.

Figs. 5-6. *Androctonus agrab* sp. n., adult ♂ holotype, habitus. 5. dorsal aspect. 6. ventral aspect. (Scale bar: 1 cm).

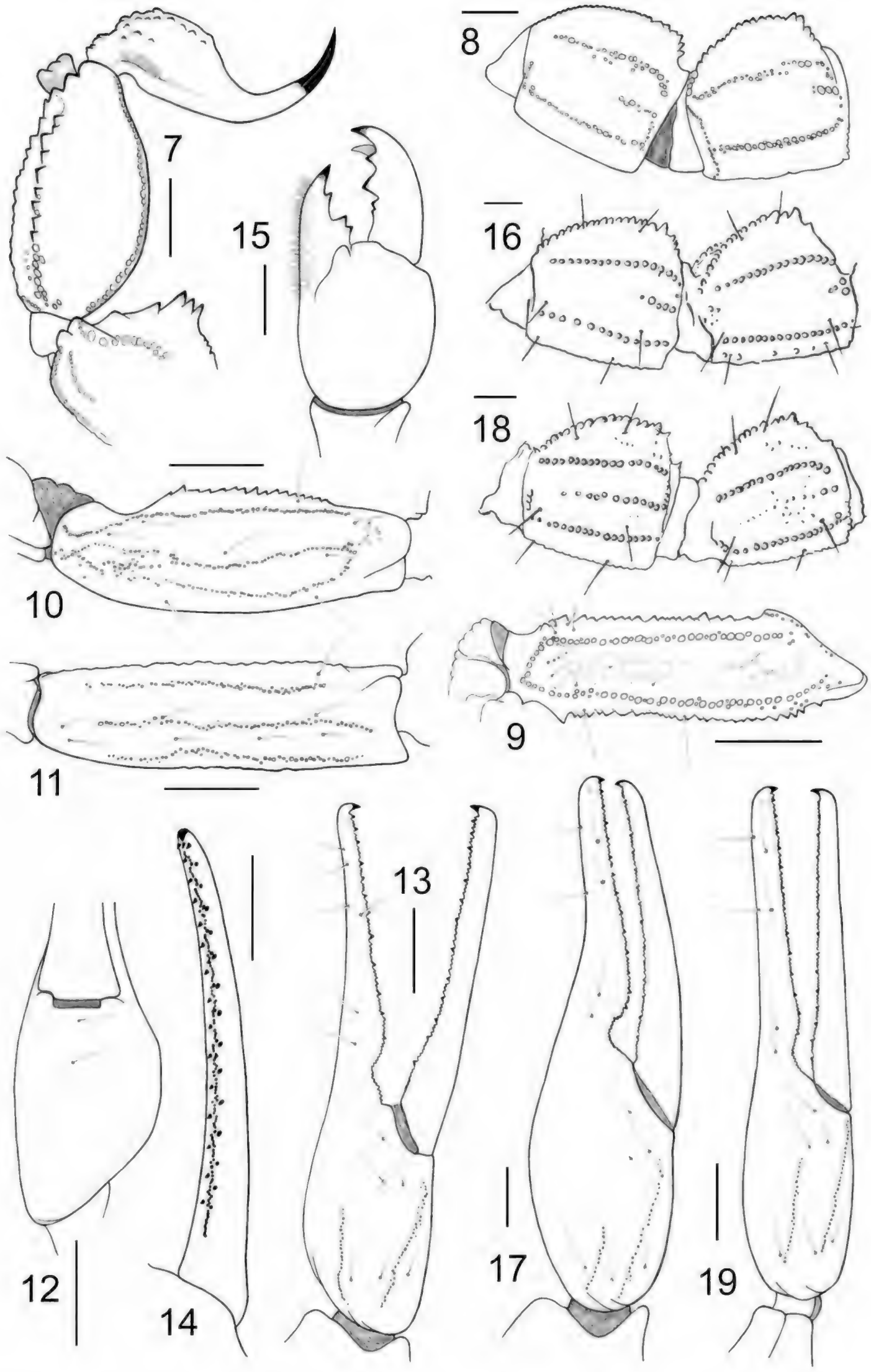
Comparative material examined.
- *Androctonus bourdoni* stat. n. (5 ex.): Morocco, Agadir, M. Vachon leg., 1939, 1♂ lectotype, 1 subadult ♂ paralectotype (MNHN, RS 2257); Morocco, Agadir, M. Vachon leg., 1939, 1♂ topotype (MNHN, RS 7023); Morocco, Taliouine, J.-B. Lacroix leg. (No. 250), 1993, 1♂ (EYCP, EY0291); Morocco, Taliouine, J.-B. Lacroix leg. (No. 329), 1993, 1♀ (EYCP, EY0335).
- *Androctonus mauritanicus* (16 ex.): Morocco, Tangier, W.R. Lourenço coll., V/2004, 3♂♂ topotypes (MNHN); Morocco, Marrakesh, E. Ythier coll., II/2010, 1♀ (EYCP, EY0058); Morocco, Marrakesh, E. Ythier coll., II/2010, 2♂♂, 5♀♀, 2 immature ♂♂ (EYCP, EY0089); Morocco, Cap Bedouza, J.-B. Lacroix leg. (No. 146), 1993, 1 subadult ♂ (EYCP, EY0263); Morocco, Abaïnou, J.-B. Lacroix leg. (No. 285), 1993, 1 subadult ♂ (EYCP, EY0307); Morocco, location unknown, J.-B. Lacroix leg. (No. 328), 1993, 1 subadult ♂ (EYCP, EY0319).

Etymology. The specific name is placed in apposition to the generic name and means scorpion in Ḥassāniyya, the Arabic dialect spoken in Western Sahara, where the new species was found.

Diagnosis. Scorpion of medium size for the genus, with a total length of 63.4 mm for the adult male holotype. General colouration brown to blackish-brown; carinae are generally darker, almost blackish. Carinae and granulations on carapace and tergites moderately developed. Sternite VII with four moderately to weakly marked carinae. Metasomal segments I to V moderately enlarged distally; dorsal depression on segments I to IV moderately to strongly marked. Lateral carinae covering 1/4 to 1/3 of the metasomal segment II and composed of only 1-3 distal granules on the segment III. Anal arc with three rounded lobes. Pedipalps with a weakly marked setation on femur, patella and chela; chela fixed finger with 14-15 rows of granules, movable finger with 13-15 rows of granules; fixed finger of the male forming a weakly to moderately marked scalloping on

the proximal dentate margin. Pectines with 29-29 teeth in male and 22-23 in female. Trichobothrium **db** of chela fixed finger distal to **est** in male, basal to **est** in female.

Description (based on male holotype. Measurements in Table 1).
Colouration. Mainly blackish-brown. Prosoma: carapace blackish-brown; carinae and eyes marked by dark pigment. Mesosoma: blackish-brown, slightly paler than carapace, with two longitudinal yellow strips. Metasomal segments I to V blackish-brown; carinae dark to blackish; vesicle reddish-brown; aculeus reddish-yellow at its base and blackish-brown at its extremity. Venter yellowish-brown; pectines pale yellow with infuscations. Tergites III to V, in male with large yellowish spots. Chelicerae yellowish with intense variegated spots; fingers reddish-brown with dark teeth. Pedipalps blackish-brown; fingers reddish-yellow with the oblique rows of granules dark reddish. Legs blackish-brown with some yellow spots distally.
Morphology. Carapace moderately to strongly granular; anterior margin almost straight and without a median concavity. Carinae moderately marked; anterior median, central median and posterior median carinae moderately granular. All furrows moderate to weak. Median ocular tubercle slightly anterior to the centre of carapace. Eyes separated by more than two ocular diameters. Three pairs of lateral eyes of moderate size. Sternum triangular and narrow, slightly longer than wide. Mesosoma: tergites moderately granular, better marked in male. Three longitudinal carinae moderately crenulate in all tergites; lateral carinae reduced in tergites I and II; tergite VII pentacarinate. Venter: genital operculum divided longitudinally, forming two semi-oval to triangular plates. Pectines: pectinal tooth count 29-29 in male holotype; middle basal lamella of the pectines not dilated. Sternites without granules, smooth with elongated spiracles; four moderately to weakly marked carinae on sternite VII; other sternites acarinate and with two vestigial furrows. Metasomal segments I to III with 10 carinae, moderately crenulated; lateral carinae covering 1/4 to 1/3 of segment II and composed of only 1-3 distal granules on segment III; ventral carinae moderately to weakly marked; segment IV with 8 carinae, moderately crenulated; the first four segments with a smooth and moderately to strongly marked dorsal depression; segment V with five carinae, the latero-ventral carinae crenulate with a few lobate denticles; ventral median carina not divided posteriorly; anal arc composed of 11-12 inconspicuous ventral teeth and three rounded lateral lobes. Intercarinal spaces weakly granular to smooth. Telson with some granulations on ventral surface; other surfaces smooth; aculeus moderately curved and with the same length as the vesicle; subaculear tooth absent. Cheliceral dentition as defined by Vachon (1963) for the family Buthidae; external distal and internal distal teeth approximately the same length; basal teeth on movable finger small but not fused; ventral aspect of both fingers and manus covered with long dense setae. Pedipalps: femur pentacarinate; patella with eight carinae; chela with only vestigial carinae; all faces weakly granular to smooth; femur, patella and chela with a weak setation. Chela fixed finger with 14-15 rows of granules, movable finger with 13-15 rows of granules; internal and external accessory granules present, strong; three accessory granules on the distal end of the movable finger next to the terminal denticle; fixed finger of the male forming a weakly to moderately marked scalloping on the proximal dentate margin. Legs: tarsus with numerous thin setae ventrally; tibial spur strong on legs III and IV; pedal spurs moderate to strong on legs I to IV. Trichobothriotaxy: trichobothrial pattern of Type A, orthobothriotaxic as defined by Vachon (1974). Dorsal trichobothria of femur arranged in **β** (beta) configuration (Vachon, 1975); chela fixed finger with trichobothrium **db** distal to **est** in male, basal to **est** in female.



Figs. 7-19. *Androctonus* spp. 7-15, *Androctonus agrab* sp. n., ♂ holotype. 7. metasomal segment V and telson, lateral aspect. 8. metasomal segments II and III, lateral aspect. 9. femur, dorsal aspect. 10-11. patella. 10. dorsal aspect. 11. external aspect. 12-13. chela. 12. ventral aspect. 13. external aspect. 14. cutting edge of pedipalp chela movable finger with longitudinal series of granules. 15. chelicera, dorsal aspect. 16-17. *Androctonus mauritanicus*, ♂ topotype. 16. metasomal segments II and III, lateral aspect (from Vachon, 1952). 17. chela external aspect. 18-19. *Androctonus bourdoni* stat. n., ♂ lectotype. 18. metasomal segments II and III, lateral aspect (from Vachon, 1952). 19. chela external aspect. (Scale bars: 2 mm except chelicera 1 mm).

Table 1. Morphometric values (in mm) and ratios of adult males of the *Androctonus* species treated in this study: *A. mauritanicus* (topotype, Tangier, Morocco), *A. bourdoni* stat. n. (lectotype, Agadir, Morocco) and *A. agrab* sp. n. (holotype).

Morphometric values (in mm)	*A. mauritanicus*	*A. bourdoni* stat. n.	*A. agrab* sp. n.
	♂ topotype	♂ lectotype	♂ holotype
Total length (including telson)	81.8	67.0	63.4
Carapace			
- Length	9.1	7.5	6.9
- Anterior width	5.9	4.8	4.7
- Posterior width	9.5	7.5	7.4
Mesosoma length	25.2	19.2	18.1
Metasomal segment I			
- Length/ width/ depth	6.1/7.6/6.3	5.1/6.1/5.0	5.0/5.9/5.0
Metasomal segment II			
- Length/ width/ depth	7.2/8.6/6.9	6.0/6.8/5.3	5.8/6.5/5.3
Metasomal segment III			
- Length/ width/ depth	7.6/9.1/7.4	6.3/6.9/5.4	6.0/6.8/5.5
Metasomal segment IV			
- Length/ width/ depth	9.0/8.8/7.4	7.5/6.6/5.4	7.0/6.6/5.6
Metasomal segment V			
- Length/ width/ depth	9.4/7.7/5.8	7.9/6.0/4.1	7.5/6.0/4.5
Telson length	8.2	7.5	7.1
Vesicle			
- Width / depth	3.8/3.0	3.0/2.4	2.9/2.4
Pedipalp			
- Femur: length/ width	7.8/2.8	7.0/2.1	6.9/2.1
- Patella: length/ width	9.5/3.9	7.6/2.8	8.0/2.8
- Chela: Length/ width/ depth	15.7/4.2/4.7	13.4/2.5/2.9	13.1/2.8/3.1
- Movable finger length	10.2	9.4	9.4
Morphometric ratios			
- Metasomal segment I length/width	0.80	0.84	0.85
- Metasomal segment II length/width	0.84	0.88	0.89
- Metasomal segment III length/width	0.84	0.91	0.88
- Metasomal segment IV length/width	1.02	1.14	1.06
- Metasomal segment V length/width	1.22	1.32	1.25
- Metasomal segment V length/depth	1.62	1.93	1.67
- Telson length/width	2.16	2.50	2.45
- Telson length/depth	2.73	3.13	2.96
- Chela length/width	3.74	5.36	4.68
- Chela length/depth	3.34	4.62	4.23
- Chela length / Movable finger length	1.54	1.43	1.39

Relationships. *Androctonus agrab* sp. n. is clearly related to *A. mauritanicus* and *A. bourdoni* stat. n., both distributed in Morocco between the Atlantic coast and the western slopes of Atlas Mountains. These two species can however be distinguished from *A. agrab* sp. n. notably by the following main features:

- *A. mauritanicus*: (i) scorpion of large size with a total length of 70-90 mm (smaller size with 63 mm in *A. agrab* sp. n.), (ii) pedipalps with a conspicuous setation on femur, patella and chela (weakly marked in *A. agrab* sp. n.), (iii) fixed finger of the male forming a conspicuous scalloping on the proximal dentate margin (weakly to moderately marked in *A. agrab* sp. n.), (iv) sternite VII with four well-marked carinae (moderately to weakly marked in *A. agrab* sp. n.), (v) male chela fixed finger with trichobothrium **db** basal to **est** (distal in *A. agrab* sp. n.), (vi) distinct morphometric values, notably with pedipalp chela manus wider and deeper than in *A. agrab* sp. n. (see Table 1).
- *A. bourdoni* stat. n.: (i) lateral carinae covering half to 2/3 of metasomal segment II and composed of 5-6 granules covering 1/4 to 1/3 of segment III (covering 1/4 to 1/3 of segment II and composed of only 1-3 distal granules on segment III in *A. agrab* sp. n.), (ii) pedipalps with a moderately marked setation on femur, patella and chela (weakly marked in *A. agrab* sp. n.), (iii) sternite VII with four well-marked carinae (moderately to weakly marked in *A. agrab* sp. n.), (iv) distinct morphometric values, notably with metasoma less wide and less deep posteriorly and pedipalp chela manus slender than in *A. agrab* sp. n. (see Table 1).

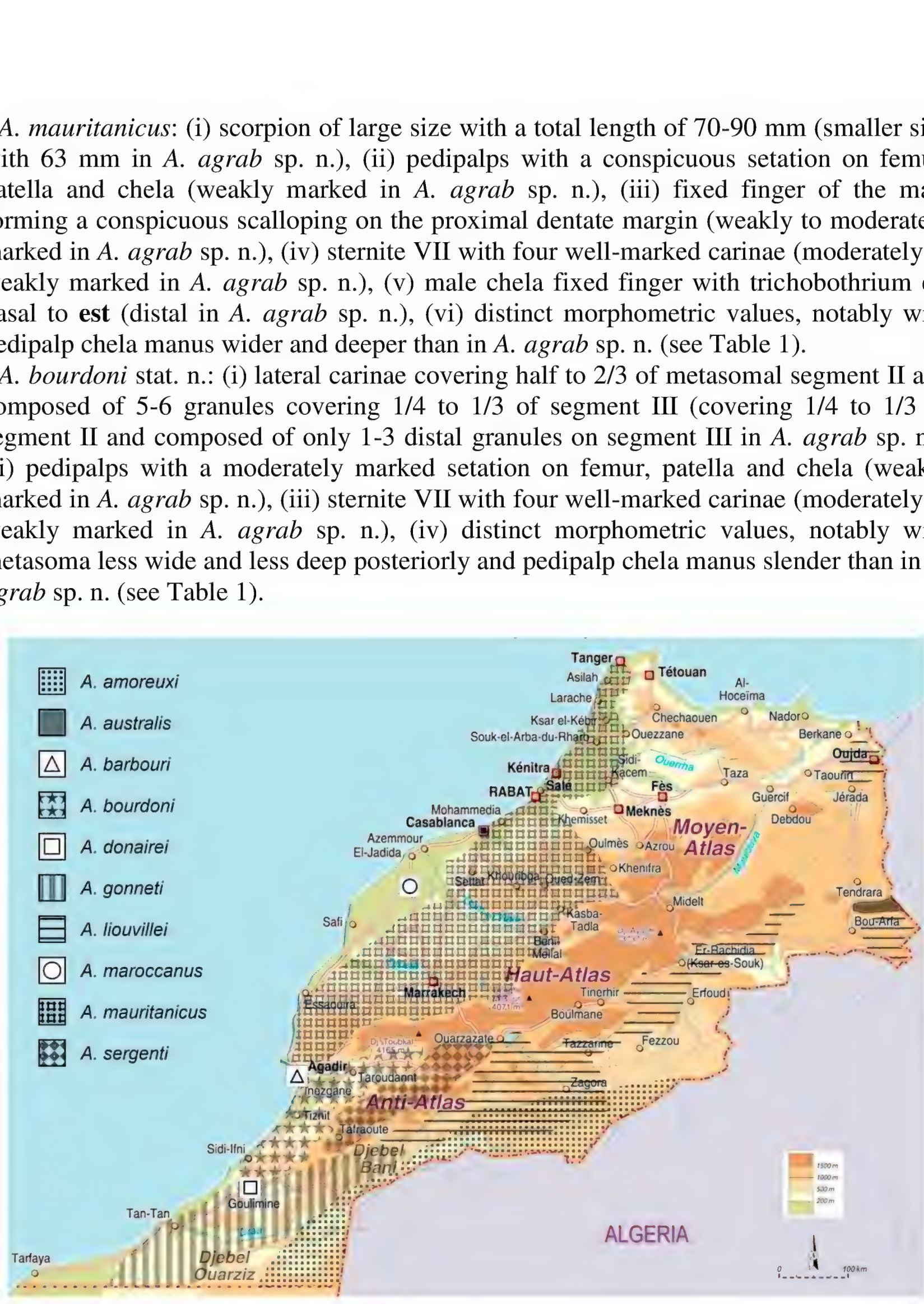


Fig. 20. Map of Morocco showing the supposed zones of distribution of species of the genus *Androctonus* (modified from Lourenço, Ythier & Leguin, 2009).

Ecological characteristics of the Adrar Sotuf region

The Adrar Sotuf is a mountain range located in the South-West of Western Sahara, 200 km south of Dakhla and 150 m east of the Atlantic coast. The climate is hot and dry, with an average annual temperature of 27°C (minimum 19°C in January, maximum 32°C in August) and total annual precipitation of 48 mm (minimum 1 mm in February, maximum 24 mm in September). The region is an immense reg with large hills reaching 400 m altitude and few dry wadi beds scattered with acacias and *Capparis*. The west-east gradient sees the moderating influences of the ocean diminishing as one goes

inland, and the oscillation of the continental and maritime air masses that meet at this latitude has hardly been favourable to rainfall in the Adrar Sotuf for several decades. Its gradual decrease has resulted in the persistence of a cycle of drought which has conditioned an important desertification of the region with a significant reduction of the woody vegetation and its associated fauna.

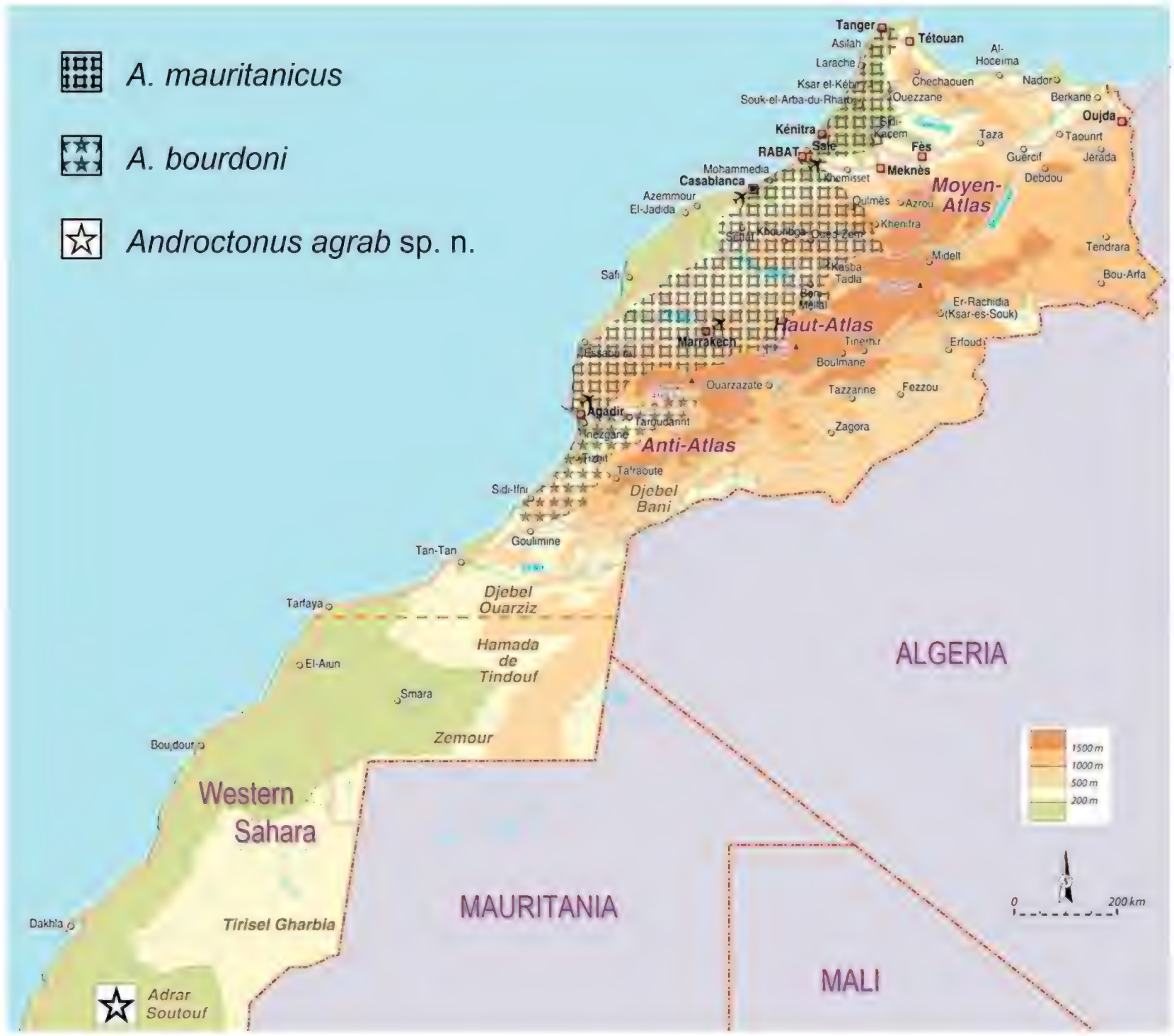


Fig. 21. Map of Morocco and Western Sahara showing the supposed zones of distribution of *Androctonus mauritanicus* and *Androctonus bourdoni* stat. n., and the type locality of *Androctonus agrab* sp. n.

Acknowledgments

We are most grateful to Michel Aymerich for permission to use his photos of the Adrar Sotuf.

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Figs. 22-23. Natural habitat of *Androctonus agrab* sp. n., Adrar Sotuf, Western Sahara (photos M. Aymerich).

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Serket (2022) vol. 18(3): 252-262.

Contributions to the scorpion fauna of Iran. Part II. *Hottentotta akbarii* sp. nov. from the Fars Province (Scorpiones: Buthidae)

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Abstract

A new species *Hottentotta akbarii* **sp. nov.** is described and illustrated from the Fars Province of Iran. *H. akbarii* **sp. nov.** is compared with *H. navidpouri* Kovařík, Yağmur & Moradi, 2018 and *H. saulcyi* (Simon, 1880). *H. akbarii* **sp. nov.** differs from its congeners by dense hirsuteness of the body, uniformly greenish yellow colouration, lacking black spot at the anterior portion of the carapace, fifth segment and telson and yellow chelicera. With this new species, the species number of genus *Hottentotta* in Iran is elevated to 10.

Keywords: Scorpions, *Hottentotta*, new species, Iran.

Introduction

Iran has a rich fauna of the genus *Hottentotta* and is a hotspot of speciation for this genus, with high-level endemism (Akbari *et al.*, 2020). Nine species have been recorded or described from Iran: *H. jayakari* (Pocock, 1895), *H. juliae* Kovařík, Yağmur & Fet, 2019, *H. khoozestanus* Navidpour, Kovařík, Soleglad & Fet, 2008, *H. lorestanus* Navidpour, Nayebzadeh, Soleglad, Fet, Kovařík & Kayedi, 2010, *H. navidpouri* Kovařík, Yağmur & Moradi, 2018, *H. saulcyi* (Simon, 1880), *H. schach* (Birula, 1905), *H. sistanensis* Kovařík, Yağmur & Moradi, 2018, and *H. zagrosensis* Kovařík, 1997. Of these, seven species are endemic in Iran, except of *H. jayakari* and *H. saulcyi* (Akbari *et*

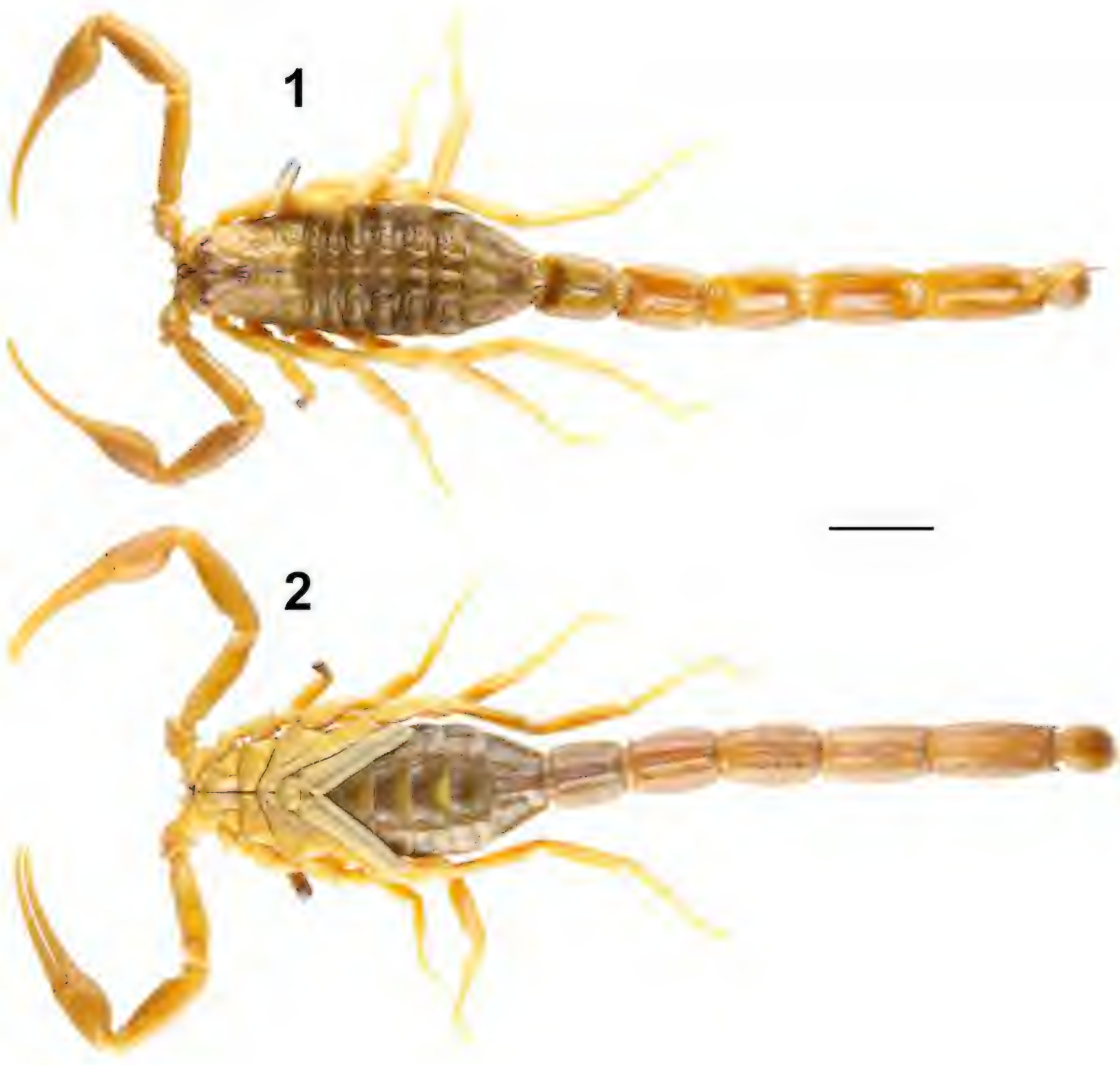
al., 2020, Barahoei *et al.*, 2020; Cokendolpher *et al.*, 2019; Mirshamsi *et al.*, 2011; Kovařík, 2007; Kovařík *et al.*, 2018, 2019).

This paper is the second one in a series of papers on scorpion fauna of Iran. This second paper reports a new species of the genus *Hottentotta* from the Fars Province.

Material and Methods

A single male of *Hottentotta akbarii* **sp. nov.** was collected from the Fars Province on 05.05.2008 by Abolfazl Akbari. The collected scorpion was preserved in 96% alcohol. Photographs of the type specimen were taken by Canon EOS 7D. Stacking of pictures was made using Helicon Focus software. Illustration method under UV illumination is after Volschenk (2005). The trichobothrial nomenclature is after Vachon (1974, 1975) and morphological nomenclature after Francke (1977), Stahnke (1971), and Hjelle (1990).

The male holotype of *Hottentotta akbarii* **sp. nov.** was deposited in Alaşehir Zoological Museum, Celal Bayar University, Alaşehir, Manisa, Turkey (AZMM).



Figs.1-2: *Hottentotta akbarii* sp. nov. Male holotype, habitus. 1. dorsal aspect. 2. ventral aspect. (Scale bar: 10 mm).

Results

Family Buthidae C.L. Koch, 1837

Genus *Hottentotta* Birula, 1908

Hottentotta akbarii sp. nov.

Figs. 1, 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 30-57, Table 1

Type material: Holotype ♂: Iran, *Fars Province*, Nurabad, Baba Monir, 30°04'13"N, 51°12'15"E, 1030 m a.s.l., 05.V.2008, A. Akbari leg. (AZMM/Sco-2008:01).

Etymology: A patronym in honour of Abolfazl Akbari (Iran) the collector of holotype specimen.

Diagnosis: Scorpion of a large size, total length of 87.53 mm in the male specimen. General colouration bright greenish yellow to dark greenish yellow, with all body with very small brown to black spots and the anterior portion of carapace light brown. Chelicerae lustrous, greenish yellow, with very small dense black spots. Trichobothrium *db* on fixed finger of pedipalp situated between trichobothria *et* and *est* but *db* is located very closely to *et*. Pectinal teeth number 36-35 in single male. All body densely hirsute except sternites and ventral surfaces of metasoma segments. Carapace hairy, with coarse granules, intercarinal area smooth. Tergites I-VI with three carinae, moderately coarse granular; tergite VII pentacarinate, sparsely coarse granular. Sternite VII with 4 moderate carinae. Femur of pedipalp with 4 carinae. Patella with 8 carinae. Sternites III-VI smooth. Chela without carinae. Movable fingers of pedipalps with 16 rows of denticles and 5 terminal denticles. Metasomal segments I-II with 10 carinae, III-IV with 8 carinae, V with 5 carinae. All metasomal segments smooth, intercarinal area without granules. All carinae with medium and equal-sized granules. All metasomal segments longer than wide.

Affinities: *Hottentotta akbarii* **sp. nov.** is a hirsute species whereas *H. jayakari* and *H. khoozestanus* are glabrous or sparsely hirsute. *Hottentotta akbarii* **sp. nov.** has uniformly greenish yellow colour whereas *H. schach* and *H. zagrosensis* are uniformly black, *H. lorestanus*, uniformly greenish grey. *Hottentotta akbarii* **sp. nov.** with greenish yellow chelicerae, telson and, fifth segment of metasoma whereas *H. juliae*, *H. sistanensis*, *H. navidpouri*, and *H. saulcyi* with black. In addition, *H. sistanensis* and *H. navidpouri* has relatively larger and *H. saulcyi* relatively smaller chela movable finger/manus ratio than *H. akbarii* **sp. nov.** This ratio in males is: in *H. navidpouri*, 3.24; in *H. sistanensis*, 3.77; in *H. saulcyi*, 2.53; whereas in male of *H. akbarii* **sp. nov.** is 2.78 (Figs. 27-29). Besides *Hottentotta akbarii* **sp. nov.** with greenish yellow carapace whereas *H. juliae* and *H. saulcyi* with black spots on anterior portion of carapace. In addition, *Hottentotta akbarii* **sp. nov.** has smaller granules on carapace than *H. saulcyi*, and lack of coarse granules at anterior portion of carapace whereas *H. saulcyi* with several coarse granules. Carapace of *H. saulcyi* more concave anteriorly than *H. akbarii* **sp. nov.**

Description: Description is based on the male holotype. Total length is 87.53 mm. Measurements are in Table (1).

Colouration: Colouration basically greenish yellow with very small black dense spots. Prosoma: Carapace light greenish yellow with very small black dense spots; anterior portion of carapace and between eyes with light brown colouration. Chelicerae lustrous greenish yellow with very small black dense spots. Tergites and sternites dark greenish yellow. Metasomal segments and vesicle greenish yellow with very small black dense spots; aculeus yellowish at its base and light reddish at its extremity. Pedipalps greenish

yellow with very small black dense spots, fixed and movable fingers without black spots. Legs pale yellow without black spots (Figs. 1-2).

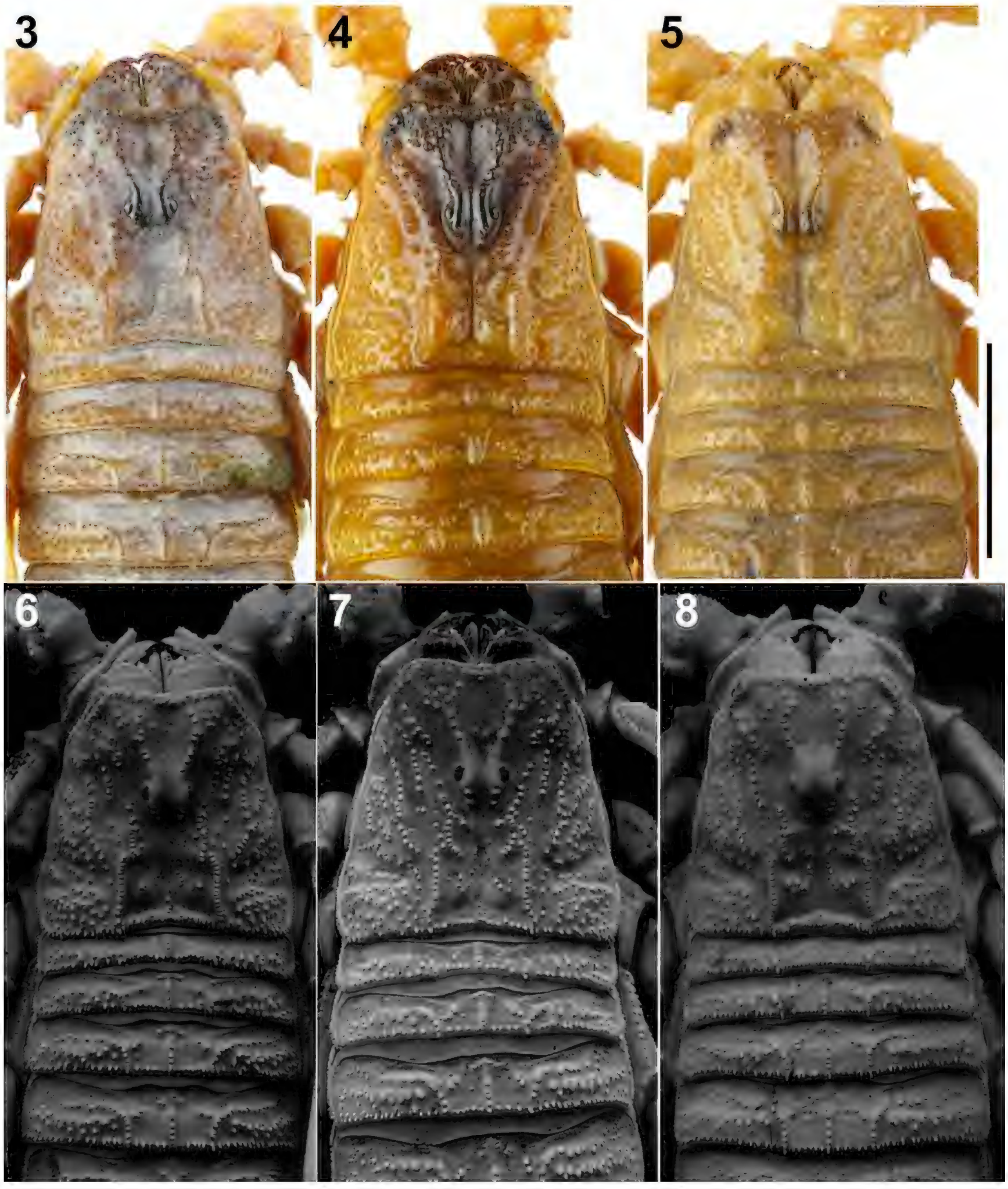
Table 1. Measurements (in mm) of the male holotype of *Hottentotta akbarii* sp. nov.

Measurements (mm)	L = length W = width D = depth	***Hottentotta akbarii* sp. n.** ♂ holotype
Carapace	L / W	9.43 / 10.44
Mesosoma	L	20.80
Tergite VII	L / W	5.68 / 10.28
Metasoma + telson	L	57.30
Metasomal segment I	L / W / D	7.37 / 6.04 / 5.35
Metasomal segment II	L / W / D	8.39 / 5.86 / 4.76
Metasomal segment III	L / W / D	8.98 / 6.15 / 4.81
Metasomal segment IV	L / W / D	10.22 / 6.20 / 4.91
Metasomal segment V	L / W / D	11.55 / 5.71 / 5.75
Telson	L / W / D	10.79 / 4.75 / 4.76
Pedipalp	L	40.75
- Femur	L / W	10.07 / 2.45
- Patella	L / W	10.57 / 3.61
- Chela	L	20.11
- Manus	L / W / D	7.23 /4.20 / 3.87
Movable finger	L	12.40
Total	**L**	**87.53**

Carapace and Mesosoma: Anterior margin of carapace slightly concave and all carapace hirsute. Carapace with moderate carinae covered with moderate granules, intercarinal area smooth, unevenly covered with coarse granules but anterior portion of carapace and area around median eyes are covered with small granules. All granules are rounded but the posterior margin of carapace has a single row of pointed granules. Sternum is of type 1, triangular shape (Soleglad & Fet, 2003). Tergites I-VI densely hirsute, with three granular carinae, intercarinal areas with rounded coarse granules but posterior margin of tergites with a single row of pointed granules. Tergite VII pentacarinate, carinae intermittently granular, intercarinal area with few coarse rounded granules. Pectinal tooth count is 36-35 in male specimen. Pectinal marginal tips slightly extend to sternite V in male. Pectines have three marginal lamellae and 8-9 middle lamellae with dense long setae. Sternites III-VI smooth and sparsely hirsute. Sternite VII smooth and bears four granulated carinae but granules are rounded (Figs. 5, 8).

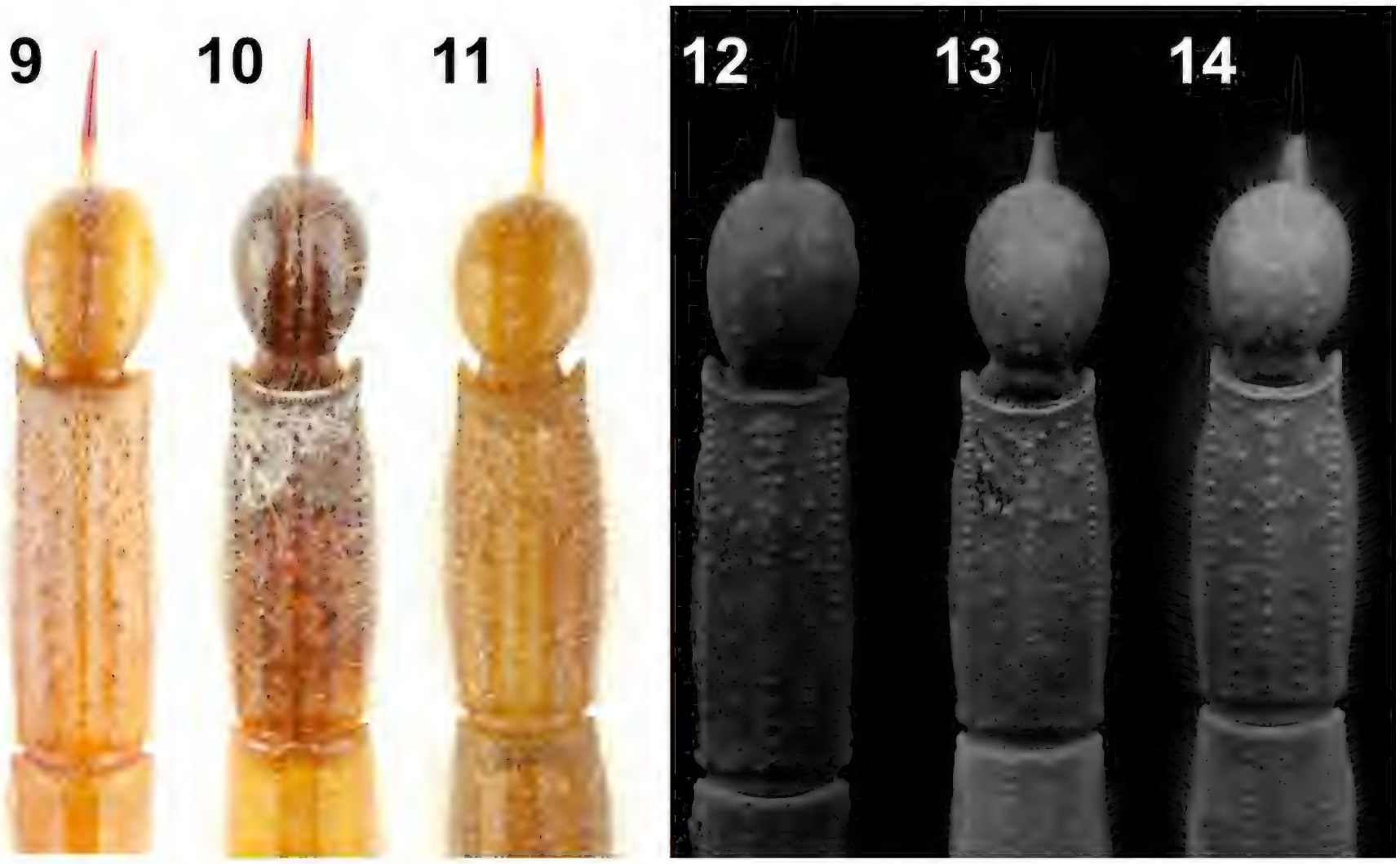
Pedipalps: Trichobothrial pattern is of Type A, orthobothriotaxic. Dorsal trichobothria of femur are arranged in β configuration. Femur trichobothrium d_2 is located on the dorsal surface; patella trichobothrium d_3 is located on the dorsal surface, on the dorsomedian carina. Pedipalps are densely hirsute and intercarinal tegument smooth. Femur bears four strong granulated carinae, with pointed granules. Patella bears eight moderate carinae; dorsal, ventral and external carinae are smooth, without granules; internal carinae are granulate, granules are pointed, intermittently located. Chela is moderately long, without carinae. Chelal trichobothrium *db* on fixed finger of pedipalp is situated between trichobothria *et* and *est* but *db* is located very closely to *et*. Male with fingers proximally straight and moderately curved distally. Movable finger with slight basal scalloping.

Movable fingers of pedipalps bear 16 rows of denticles and five terminal denticles. Fixed fingers of pedipalps bear 15 rows of denticles (Figs. 40-54).



Figs. 3-8. Carapace, dorsal view. 3,6. *H. navidpouri.* 4,7. *H. saulcyi.* 5,8. *H. akbarii* sp. nov. 3-5. Under white light. 6-8. Under UV light.

Legs: Tarsomeres bear two rows of short and strong spiniform setae on the ventral surface and numerous thin macrosetae on the other surfaces. Basitarsus of leg II and III with two rows of spiniform setae on the ventral surface anteriorly and one row posteriorly; leg IV with only six spiniform setae anteriorly (leg I unknown). Pedal spur of legs without setae. Femur and tibia with distinct carinae. Tibial spurs present and long on third and fourth legs (Figs. 55-57).



Figs. 9-14. Fifth metasomal segment and telson, ventral aspect. 9,12. *H. navidpouri.* 10,13. *H. saulcyi.* Figs. 11,14. *H. akbarii* sp. nov. 9-11. Under white light. 12-14. Under UV light.

Metasoma and telson: The entire metasoma densely hirsute except dorsal surface, which is lacking setae; only a few setae are on dorsal surface of segment I. All metasomal segments longer than wide; length of segments increases posteriorly. Segments I-II bear 10 carinae; segments III-IV bear 8 carinae; and segment V bears five carinae. All carinae moderate with moderate and intermittently located, consistent sharp granules; only dorsoventral carinae of segment V lacks granules. Telson hirsute, bulbous but finely elongated, tegument smooth and finely granulated (Figs. 34-39).

Discussion

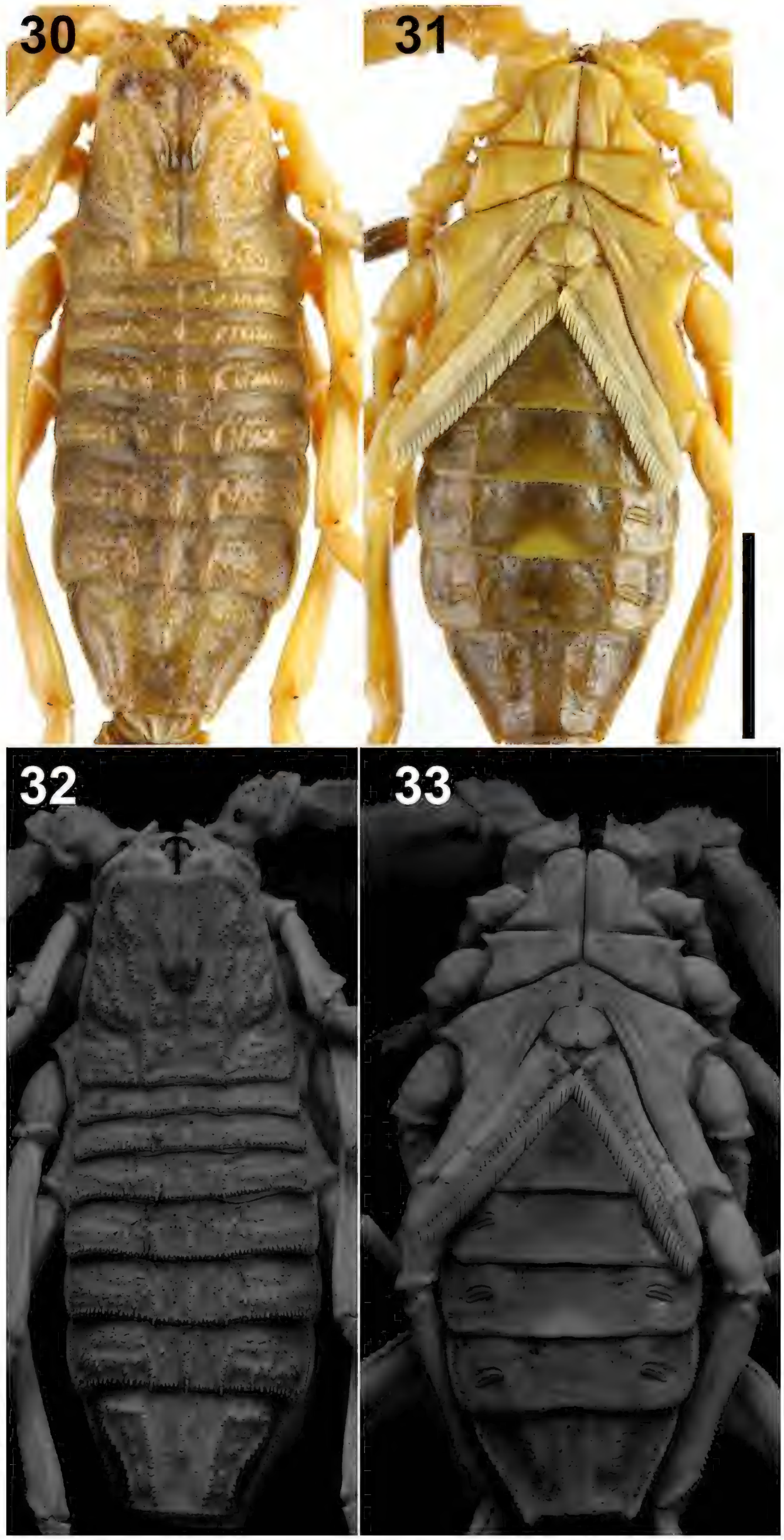
Fars Province includes six species of *Hottentotta*: *H. jayakari* (Sanaei-Zadeh *et al.*, 2017), *H. juliae* (Akbari *et al.*, 2020; Kovařík *et al.*, 2019; Navidpour *et al.*, 2012); *H. navidpouri* (Akbari *et al.*, 2020), *H. saulcyi* (Kovařík, 2007; Navidpour *et al.*, 2012), *H. schach* (Akbari *et al.*, 2020), and *H. zagrosensis* (Akbari *et al.*, 2020, Kovařík, 1997). *Hottentotta akbarii* **sp. nov.** is the seventh species from Fars Province belonging to the genus *Hottentotta.* Fars Province is located at the intersection of ranges of these *Hottentotta* species, of which two are so far known only from this province: *H. juliae* (Akbari *et al.*, 2020; Kovařík *et al.*, 2019; Navidpour *et al.*, 2012) and *H. akbarii* sp. nov., which is the second endemic species of Fars Province, and the eighth endemic species of this genus in Iran.

Acknowledgments

We would like to thank Abolfazl Akbari (Karaj, Iran) for collecting the holotype specimen, and Dr. Victor Fet (West Virginia, USA) for his comments and for improving the English text.

Figs. 15-20. Fifth metasomal segment and telson, lateral aspect. 15,18. *H. navidpouri.* 16,19. *H. saulcyi.* 17,20. *H. akbarii* sp. nov. 15-17. Under white light. 18-20. Under UV light.

Figs. 21-29. Chela. 21,24,27. *H. navidpouri.* 22,25,28. *H. saulcyi.* 23,26,29. *Hottentotta akbarii* sp. nov. 21-23. dorsal aspect. 24-26. ventral aspect. 27-29. lateral aspect.



Figs. 30-33. *H. akbarii* sp. nov. Carapace and Mesosoma. 30,32. dorsal view. 31,33. ventral view. 30-31. Under white light. 32-33. Under UV light.

Figs. 34-39. *H. akbarii* sp. nov. Metasoma. 34,37. lateral view. 35,38. ventral view. 36,39. dorsal view. 34-36. Under white light. 37-39. Under UV light.

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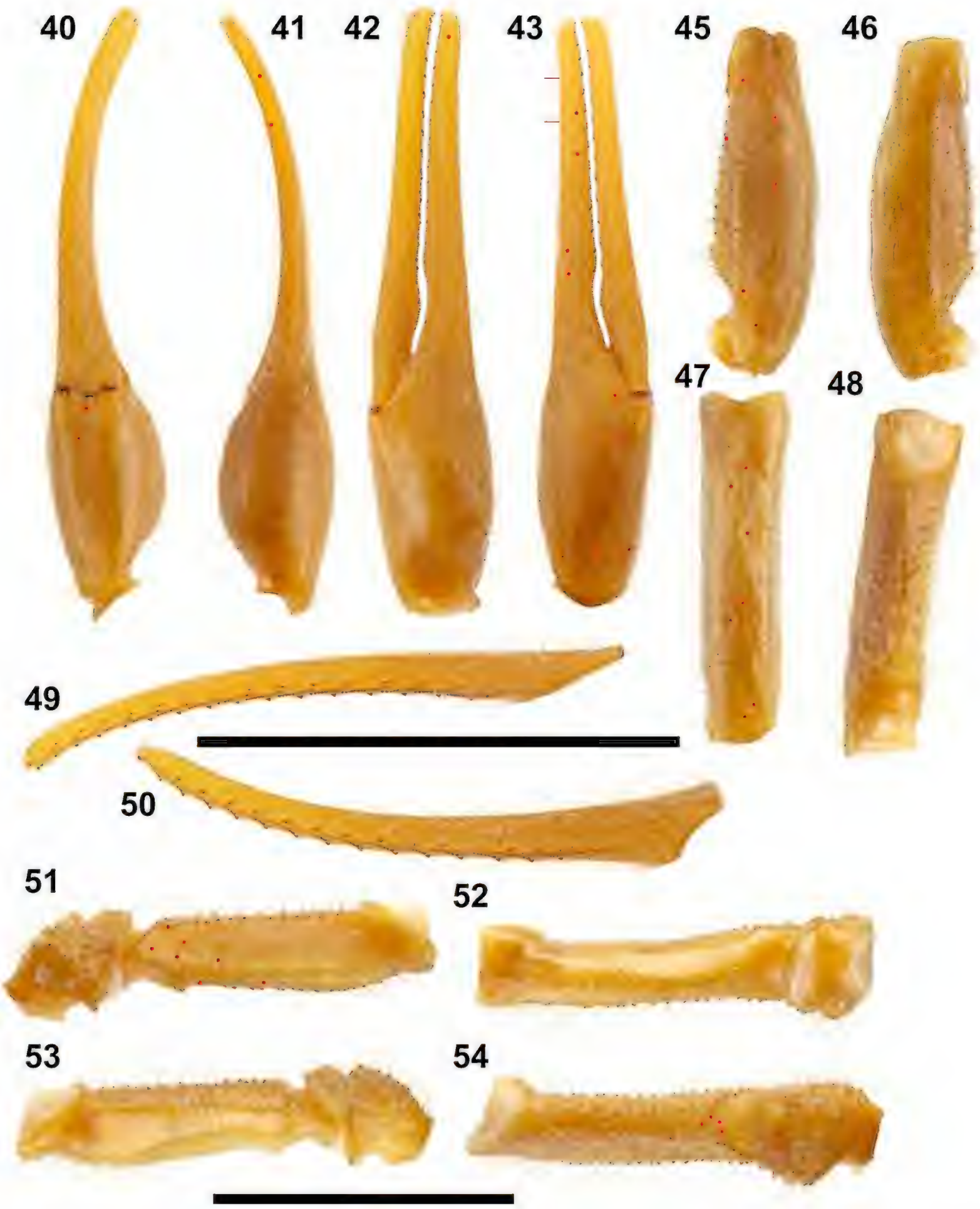

Figs. 40-54. *H. akbarii* sp. nov. Pedipalp segments. 40-43. Chela. 45-48. Patella. 49-50. Movable (49) and fixed (50) fingers dentition. 51-54. Femur and trochanter. 40,46,53. ventral view. 41,45,51. dorsal view. 42,48,54. internal view. 43,47,52. external view. Trichobothrial pattern is indicated by red circles.
(Scale bar: 10 mm).

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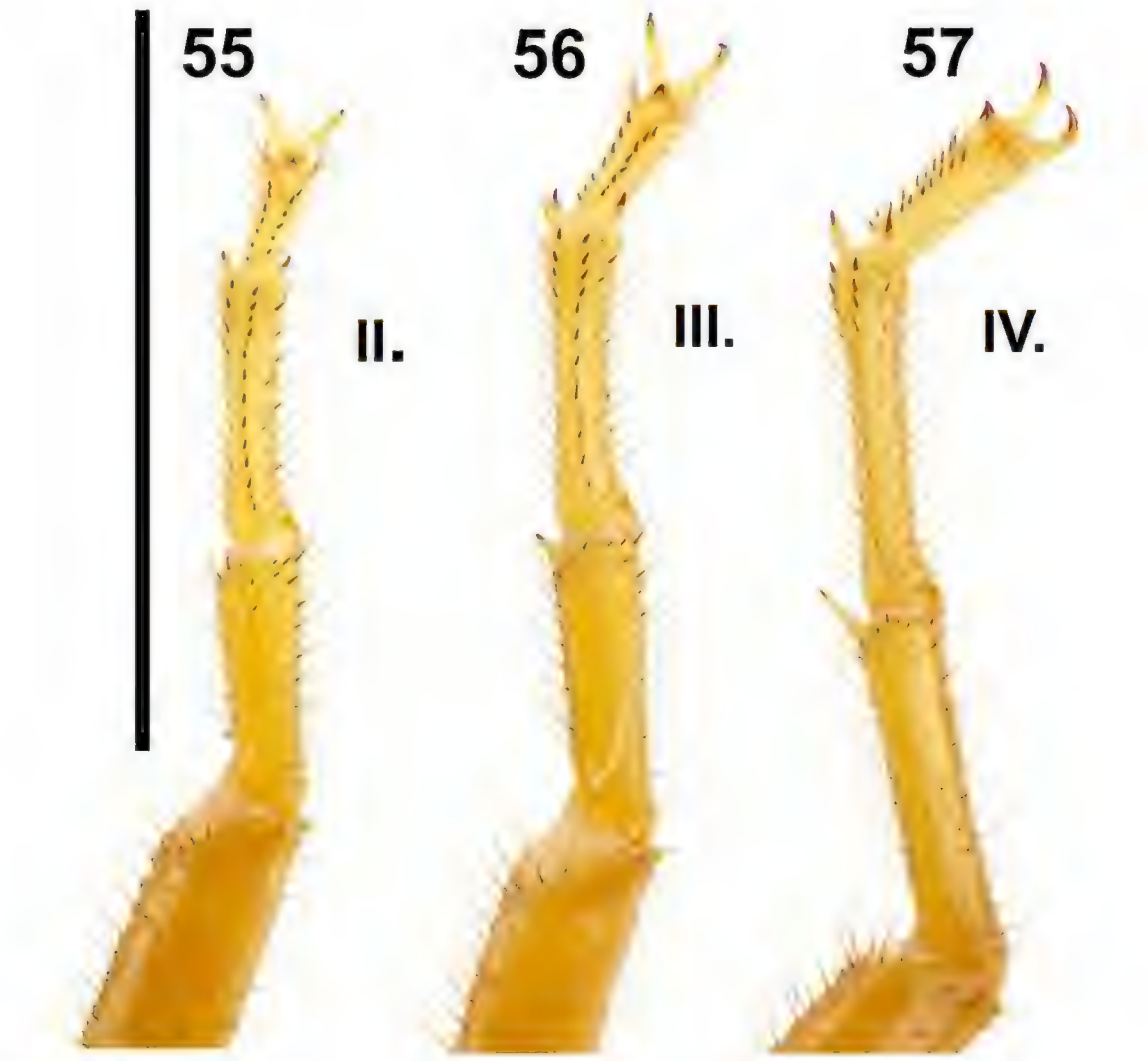

Figs. 55-57. *H. akbarii* sp. nov. Right legs II-IV, retrolateral aspect.

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***Hottentotta akbarii* Yağmur, Moradi, Tabatabaei & Jafari, 2022**
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On the poorly known species *Buthiscus bicalcaratus* Birula, 1905 (Scorpiones: Buthidae)

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Abstract

The monotypic genus *Buthiscus* was described by Birula (1905) with the species *Buthiscus bicalcaratus* from the Sahara Desert of southern Tunisia. Until now, huge gaps exist in the knowledge of this species which is classified as endemic to North Africa. This paper aims to enrich the existing knowledge on this poorly known species with redescribing specimens of both sexes collected from Libya using widely illustrated redescription, in light of modern standards ruling the taxonomy of scorpions.

Keywords: Scorpiones, Buthidae, *Buthiscus bicalcaratus*, Libya.

Introduction

The monotypic genus *Buthiscus* was established by Birula (1905), with *Buthiscus bicalcaratus* based on two males and two females, syntype specimens that were collected from the Sahara Desert of southern Tunisia. Subsequently, the taxonomic status of this genus and species has been synonymized, redescribed, and clarified by a number of authors (Pallary, 1937; Sergent 1941; Vachon, 1941, 1942; Pérez, 1974; Lourenço, 2002).

The geographical distribution of this species extended across North Libya, Tunisia, Algeria and north-eastern part of Mali (Birula, 1905; Pallary, 1937; Vachon, 1941; Sadine *et al.*, 2011; Goyffon *et al.*, 2012; Sadine, 2018; Sadine *et al.*, 2018; Lourenço, 2002; Aboshaala *et al.*, 2020; Sadine *et al.*, 2020).

In this paper, we aim to stabilize the nomenclature of this taxon, designate and produce a detailed and widely illustrated redescription, in light of modern standards ruling the taxonomy of *Buthiscus bicalcaratus*.

Material and Methods

Specimens of *Buthiscus bicalcaratus* were collected during night using ultraviolet light in Misurata city, North Libya (Fig. 1) in August 2021. The collected scorpions were preserved in ethanol 75%. Identifications of specimens were after Vachon (1952) and Lourenço (2002). Photographs were taken with a Canon EOS 7D. Stacking of pictures were made using Helicon Focus software. The Illustration method under UV illumination is after Volschenk (2005). The trichobothrial nomenclature is after Vachon (1974) and morphological nomenclature after Francke (1977), Stahnke (1972), and Hjelle (1990).

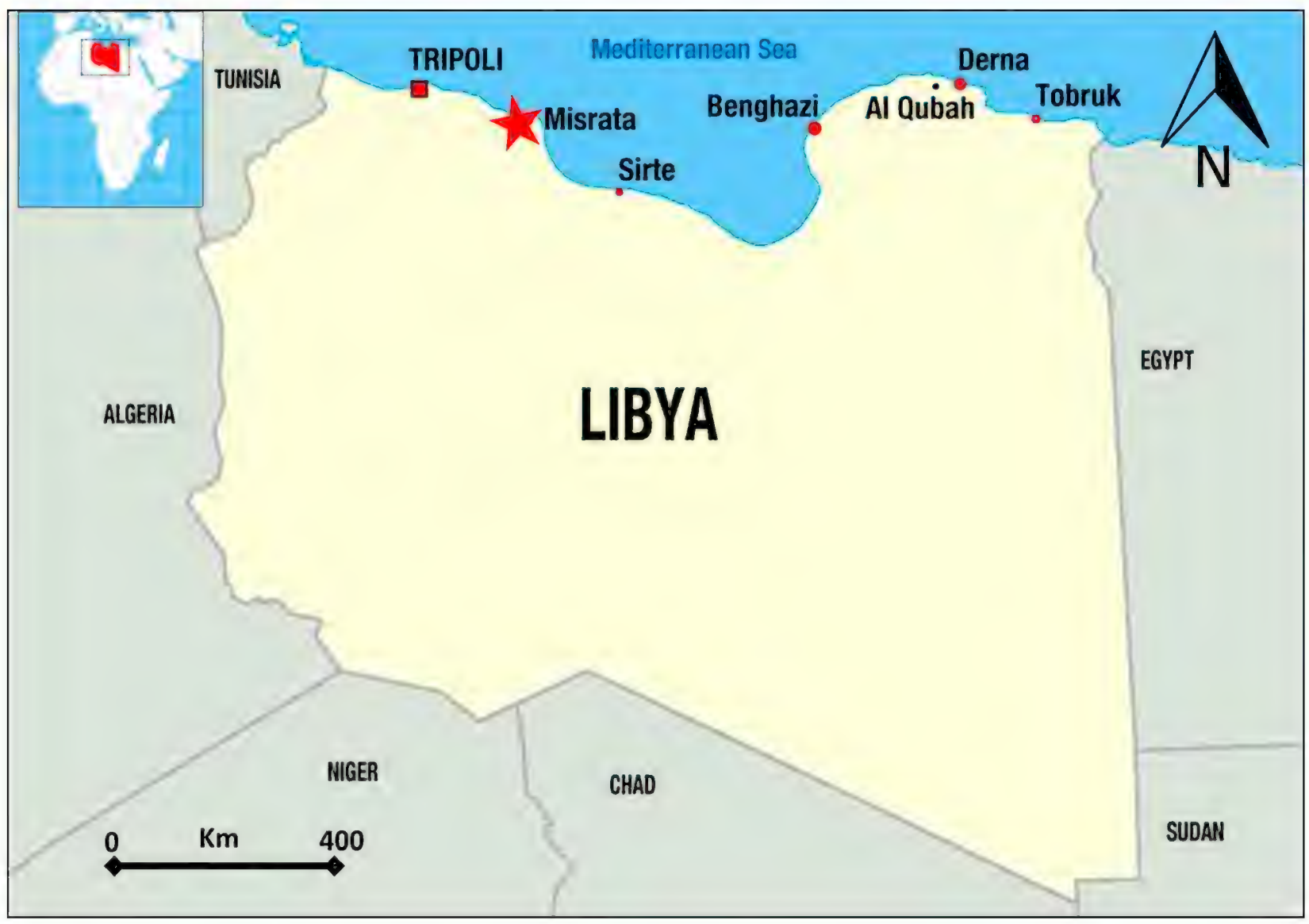

Fig. 1. Map of Libya, showing the scorpion sampling area (star).

Taxonomic treatment

Family **Buthidae** C.L. Koch, 1837
Genus ***Buthiscus*** Birula, 1905
Buthiscus bicalcaratus Birula, 1905
(Figs. 2-9, Table 1)

Buthiscus bicalcaratus Birula, 1905: 623-624.
Buthacus ducrosi Pallary, 1937: 97-98.

Buthacus ducrosi: Sergent, 1941: 355; Pérez, 1974: 19.
Trichobuthus grubleri Vachon, 1941: 339-350.
Buthiscus bicalcaratus: Birula, 1910: 154, 156; Birula, 1917: 214, 224; Vachon, 1942: 419-421; Foley, 1945a: 64-66; Foley, 1945b: 6-7; Vachon, 1948: 176-188; Vachon, 1952: 89-95; Vachon, 1955: 101-105; Stahnke, 1972: 122; Pérez, 1974: 20; El-Hennawy, 1992: 97, 115; Kovařík, 1998: 105; Lourenço, 2002: 11-16, Goyffon *et al.*, 2012: 363-364; Aboshaala *et al.*, 2020: 181-183.

Material examined: 2♂♂ and 1♀ from sandy plain, Misurata region, Assiuta, Libya, at 32°14'00.0"N 14°59'00.0"E, 80 m asl., 01/08/2021 (leg. F. Aboshaala). Material was deposited in Alaşehir Zoological Museum, Manisa Celal Bayar University, Alaşehir, Manisa, Turkey (AZMM/Sco-2021:16-18).

Description

This scorpion has a median size, with an average total length between 58 to 63 mm (measurements in Table 1).

Colouration: General colouration bright yellowish (Figs. 2-3). Prosoma yellowish with the surrounding area and areas between the median eyes reddish brown. Chelicera is pale yellow without reticulation with teeth reddish brown to dark brown. Mesosoma and metasoma uniformly yellow except fifth segment and telson, fifth segment yellow to brownish yellow; vesicle brownish yellow, posterior half of the sting reddish yellow; pedipalps and legs yellowish, fingers of chela dark yellow with movable finger condyles reddish brown.

Fig. 2. *Buthiscus bicalcaratus* in natural habitat. A. male. B. female.

Morphology

Prosoma: The carapace is slightly wider than long (Fig. 4). Carapace moderately granular; between central median, posterior median and anterior median carinae with fine granules. Anterior margin of carapace with coarse granules. Central median, and anterior posterior median carinae moderate with some distinct and coarse granules. Anterior margin of carapace with 8-9 distinct setae. Posterior margin with coarse granules. Anterior and posterior furrows moderate. Median ocular tubercle located slightly anteriorly from the centre; median eyes separated by almost as diameters of two eyes, posterior of median eyes with some coarse granules. Anteriomedian corner of carapace with five lateral eyes, last two eyes vestigial.

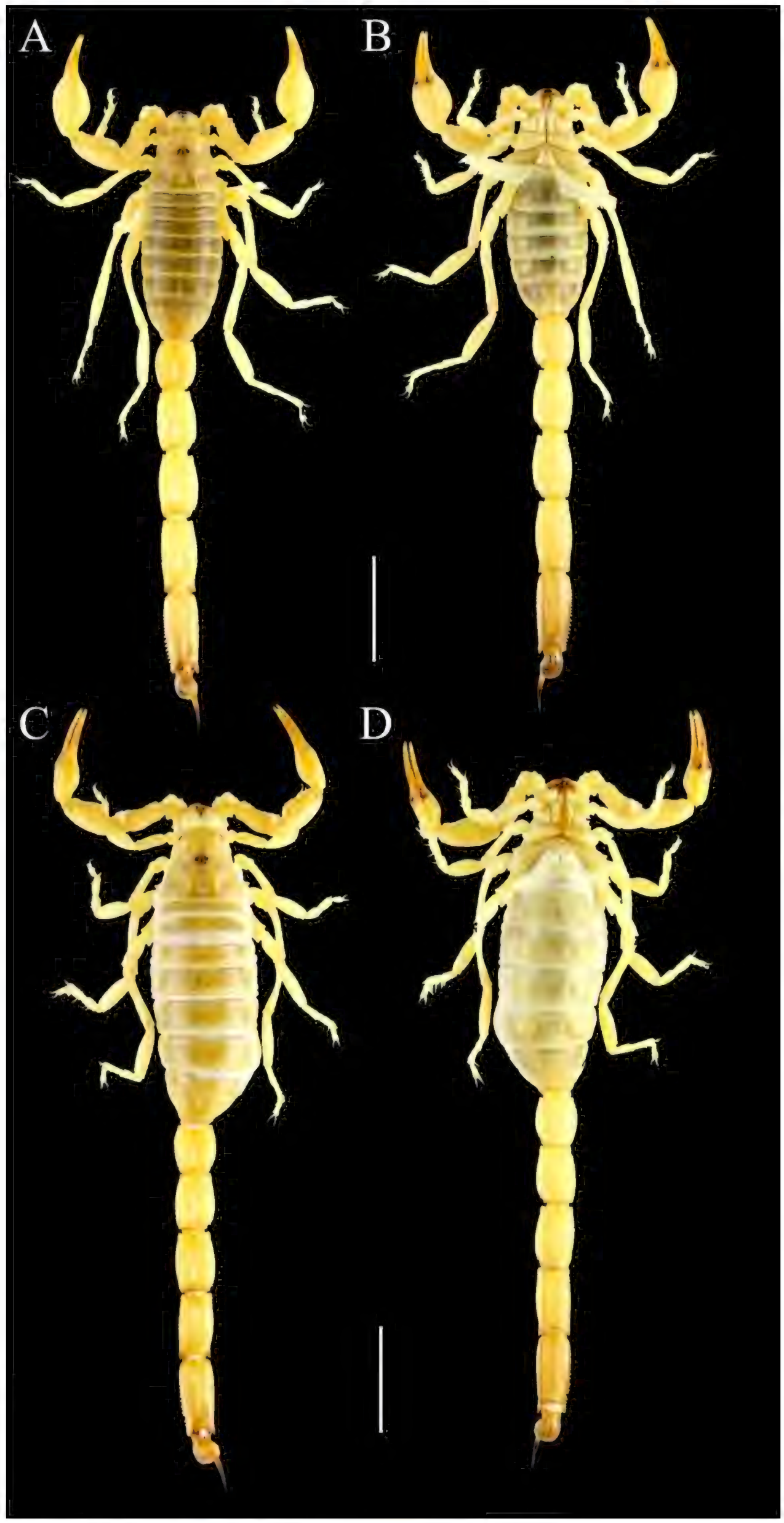

Fig. 3. *Buthiscus bicalcaratus*, habitus. A-B. Male, dorsal and ventral views. C-D. Female, dorsal and ventral views. (Scale bar: 10 mm).

Table 1. Measurements (in millimetres) of specimens of *Buthiscus bicalcaratus*.

Buthiscus bicalcaratus	♂	♂	♀
Total length (telson included)	58.66	60.14	63.96
Mesosoma length	13.56	16.45	20.89
Carapace			
- length	6.35	6.10	7.10
- width	6.90	7.00	8.20
Metasoma length	38.70	37.59	35.97
Metasoma segment I			
- length	4.11	4.80	4.70
- width	4.30	4.05	4.00
- depth	3.62	3.55	3.50
Metasoma segment II			
- length	5.50	5.62	5.58
- width	4.00	3.85	3.85
- depth	3.48	3.55	3.22
Metasoma segment III			
- length	5.81	5.91	5.80
- width	3.90	3.81	3.70
- depth	3.64	3.35	3.40
Metasoma segment IV			
- length	6.79	6.80	6.37
- width	3.60	3.10	3.35
- depth	2.83	3.00	2.82
Metasoma segment V			
- length	8.24	7.80	7.35
- width	3.35	2.90	2.95
- depth	2.80	2.75	2.45
Telson			
- length	6.96	7.21	7.13
- width	2.35	2.35	2.14
- depth	2.13	2.31	2.32
Sting length	3.64	3.39	3.43
Pedipalp			
- Femur length	4.94	4.80	4.51
- Femur width	1.79	2.01	2.08
- Femur depth	1.32	1.35	1.52
- Patella length	5.89	6.08	9.47
- Patella width	2.96	2.99	3.11
- Patella depth	2.26	2.30	2.09
- Chela length	9.16	10.10	9.47
- Chela width	3.55	3.49	2.41
- Chela depth	3.82	3.62	2.45
Movable finger length	4.75	4.55	2.41

Mesosoma: Tergites I-VI tricarinate, all carinae weak and finely granular, posterior parts of tergites with moderate scattered granules, posterior margins with a row of moderate

granules. Tergite VII pentacarinate; all carinae moderate and moderately granular, intercarinal area with scattered moderate granules. Sternites: Sternites III-VI smooth, without carinae; sternite VII smooth with four finely granulate carinae (Fig. 4). Pectinal teeth count 13-14 in females and 20-21 and 21-21 in males.

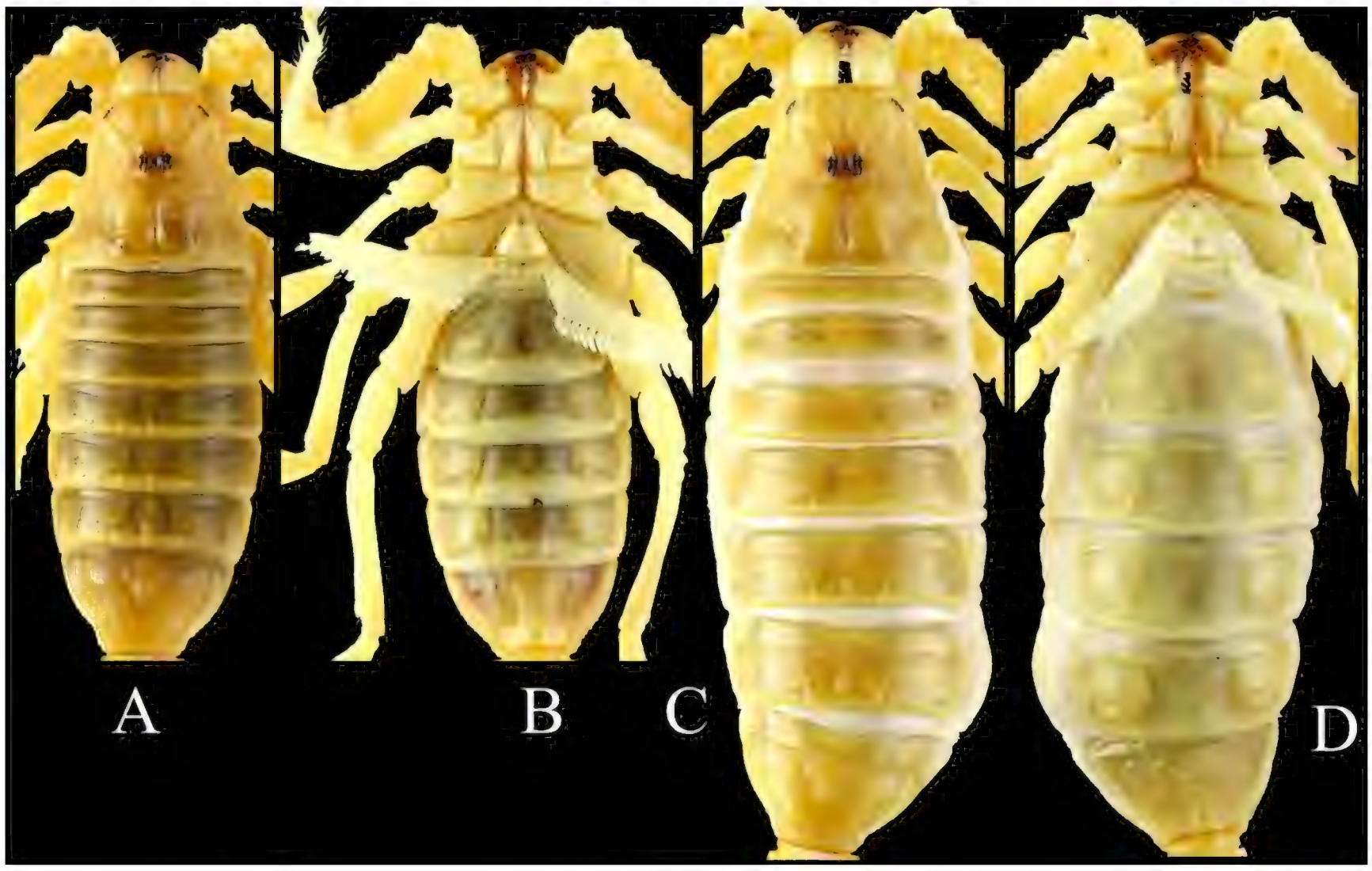

Fig. 4. *Buthiscus bicalcaratus*, carapace and tergites, dorsal and ventral views. A-B. Male. C-D. Female.

Metasoma: All segments are longer than wide (Fig. 5); length increases and width slightly decreases posteriorly on I-V. Segments I to III with 10 carinae; segment IV with eight carinae; segment V with five carinae. Dorsolateral carinae and lateral supramedian carinae on segments I-IV moderate, crenulate, on I-IV moderate, slightly crenulate. Lateral inframedian carinae on the segment I complete, moderate, slightly crenulate; on segment II present on posterior half, weak, with eight granules in males, 12 granules in females; on segment III present on posterior quarter, weak, with three granules in males, four granules in females; on segment IV absent. Ventrolateral carinae and ventral submedian carinae on segments I-IV moderate, crenulate, granules weak on segments I, moderate on segments II-III, distinct on segments IV, granules more distinct in females than males. Segment V with five carinae: dorsolateral carinae weak, rounded; ventro-lateral carinae strong, with long and dense granules, larger posteriorly, granules more distinct in females than males; ventromedian carina weak, with two rows of fine granules and these two rows bifurcated on posterior margin. Surfaces of metasomal segments, finely and irregularly granular, ventral surface smooth. Metasomal segments with little number setae, on segment I-IV three rows, on segment IV higher number scattered. Telson elongated and thin, almost smooth, aculeus longer than vesicle, subaculear tubercle completely absent and with scattered short setae, vesicle is slightly bigger in females than males. Chelicerae is typical as in family Buthidae.

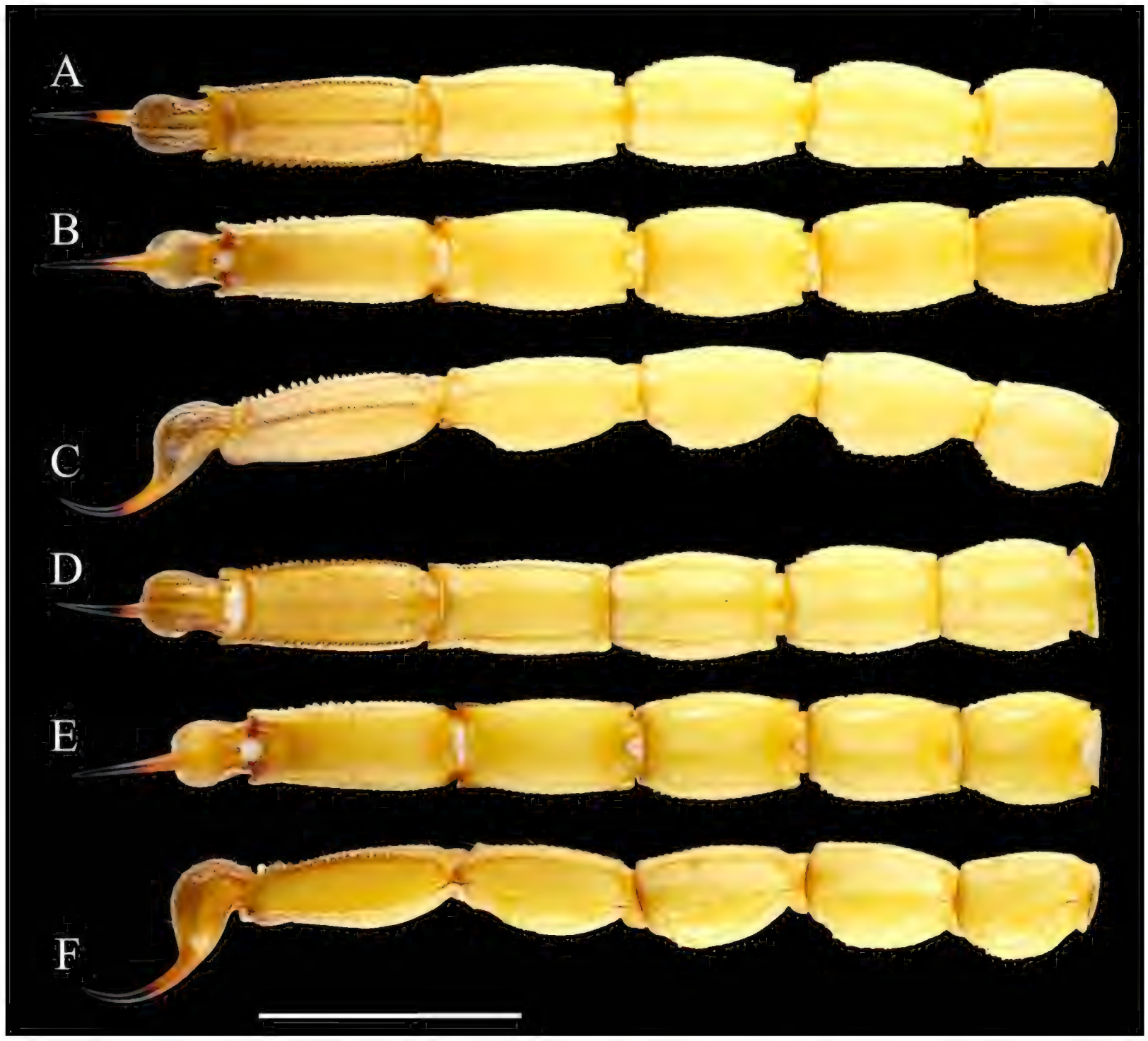

Fig. 5. *Buthiscus bicalcaratus*, metasoma. A-C. Male. D-F. Female. A,D. ventral view. B,E. dorsal view. C,F. lateral view. (Scale bar: 10 mm).

Pedipalps: Trichobothrial pattern Type A, neobothriotaxic (femur with 3, patella with 7 trichobothria on the external surface). Dorsal trichobothria of the femur are arranged in β configuration with d_2 situated on the dorsal surface (Fig. 6).

Femur: Femur pentacarinate; dorsointernal, dorsoexternal and ventrointernal carinae strong, with distinct granulose; ventroexternal carina moderate, rounded with a few coarse granules; internal median carinae weak, with irregular coarse and pointed granules. Surfaces smooth, with the dorsal surface a few moderate other sides with a few small granules (Fig. 6).

Patella: Patella with seven carinae; dorsointernal carina strong, with equally spaced coarse rounded granules; dorsomedian carina weak, with a few very small granules; dorsoexternal carina weak, smooth; exteriormedian carina weak, smooth; ventroexternal carinae weak, smooth; ventromedian carina weak, smooth; ventrointernal carina with spaced moderate granules. Surfaces are smooth and lustrous (Fig. 6).

Chela: Manus slender, smooth, and lustrous; extremely swollen, subglobose in males, not strongly swollen in females. Fingers stocky. Fixed finger and movable with 10 oblique denticle rows. Pedipalp chela with very distinct gap in males (Fig. 6) but without it in females (Fig. 7). Similarly, movable finger has a slight basal scalloping in males (Fig. 6) but, without in females.

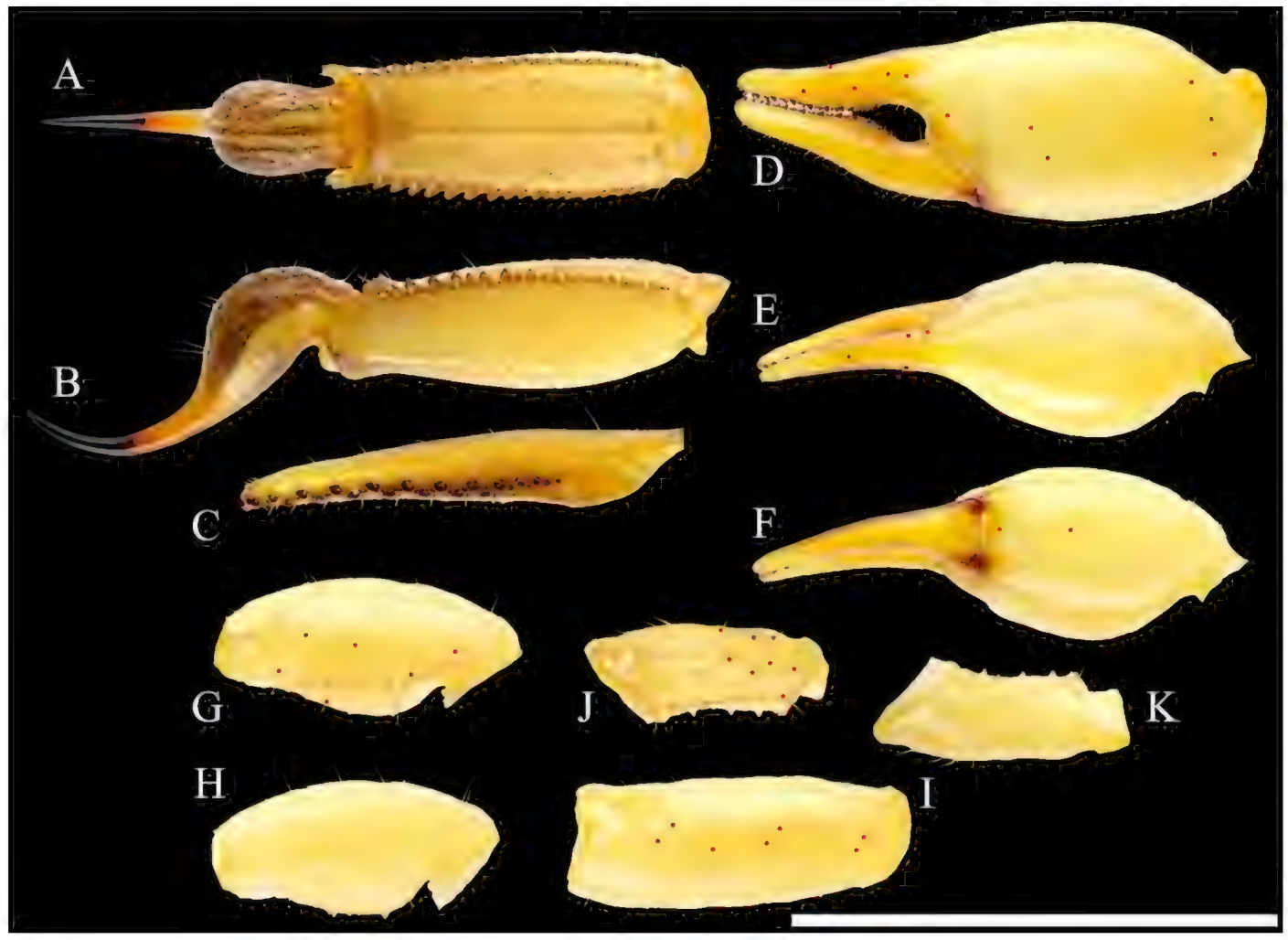

Fig. 6. *Buthiscus bicalcaratus*, male. A-B. Metasomal segment V and telson. A. ventral view. B. lateral view. C. Movable finger dentition, dorsal view. D-F. pedipalp chela. D. external view. E. dorsal view. F. ventral view. G-I. Pedipalp patella. G. dorsal view. H. ventral view. I. external view. J-K. Pedipalp femur. J. dorsal view. K. ventral view. (Scale bar: 10 mm).

Fig. 7. *Buthiscus bicalcaratus*, female. A-B. Metasomal segment V and telson. A. ventral view. B. lateral view. C. Movable finger dentition, dorsal view. D-F. pedipalp chela. D. external view. E. dorsal view. F. ventral view. G-I. Pedipalp patella. G. dorsal view. H. ventral view. I. external view. J-K. Pedipalp femur. J. dorsal view. K. ventral view. (Scale bar: 10 mm).

Legs: Basitarsus and telotarsus on all segments with fine setae (Figs. 8-9). Tibial and pedal spurs present on legs IV; tibial spur vestigial or absent on legs III. Basitarsi I-III with bristle-combs.

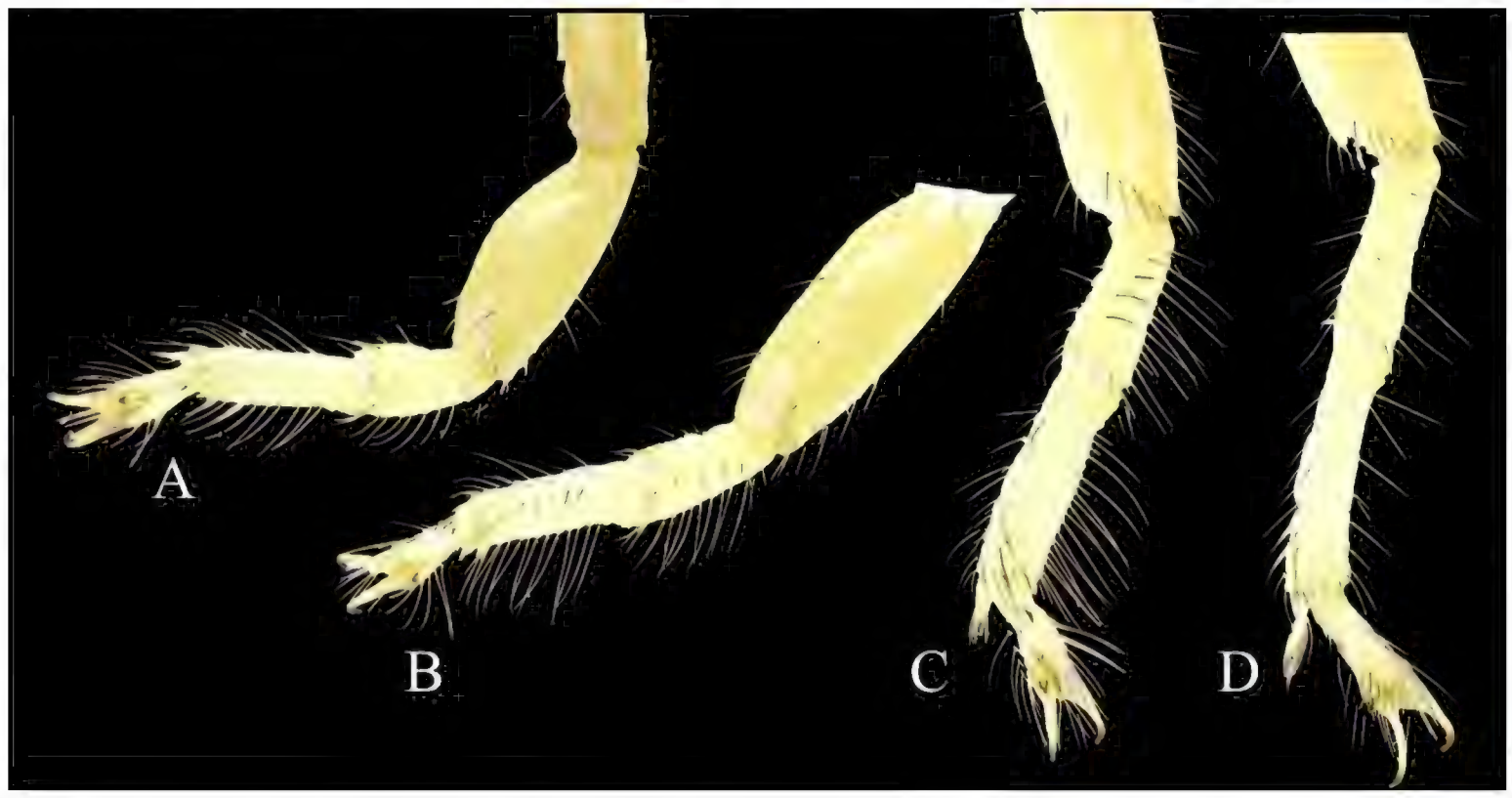

Fig. 8. *Buthiscus bicalcaratus*, male, right legs, ventral view. A. First leg. B. Second leg. C. Third leg. D. Fourth leg.

Fig. 9. *Buthiscus bicalcaratus*, female, right legs, ventral view. A. First leg. B. Second leg. C. Third leg. D. Fourth leg.

Habitat: The collecting locality is a sandy habitat with low vegetation in the Misurata region (Fig. 10). *Buthiscus bicalcaratus* lives in burrows. See Aboshaala *et al.* (2020) for detailed ecological observations.

Fig. 10. Natural habitat of *Buthiscus bicalcaratus*.

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Notes and remarks on *Buthacus* species of Central Algeria (Scorpiones: Buthidae)

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Abstract

The genus *Buthacus* Birula, 1908 (Family Buthidae) regroups about 30 species commonly known as sand scorpions. In the Algerian sandy deserts, in particular, this group shows a micro-endemic populations. The present paper summarizes the exhaustive list of *Buthacus* species in Ghardaïa region (Central Algeria), basing on sampling period of 12 months (2021). As a preliminary result, five species were recorded from the study area: *B. arenicola*, *B. birulai*, *B. elmenia*, *B. samiae*, and *B. spinatus*. Of which, two species are original from Algerian Eastern Erg (*B. arenicola* and *B. birulai*) while, the other species were recently identified from Ghardaïa region. All these species show a close affinity to Erg or sandy biotopes except *B. samiae* which presents a wide distribution in study area and in sandy Reg. Also, it has the ability to cohabit with other *Buthacus* such as *B. spinatus* in the North and *B. elmenia* in the south.

Keywords: Sand Scorpion, *Buthacus*, Sahara, Ghardaïa, Algeria.

Introduction

Algerian scorpion diversity includes more than 49 species divided into 14 genera and three families (Sadine *et al.*, 2020; Mekahlia *et al.*, 2021). Of which, *Buthus* Leach,

1815 is the most represented by 10 species (Ythier *et al.*, 2021), *Buthacus* Birula, 1908 with nine species, *Androctonus* Ehrenberg, 1828 with five species (Sadine, 2018a; Sadine *et al.*, 2020), while the other genera are represented each with three species at most (Sadine *et al.*, 2020).

The genus *Buthacus* was created by Birula (1908), as a subgenus of *Buthus* Leach, 1815, comprising as a species *Buthus leptochelys* (Ehrenberg, 1829) described from Sinai (Egypt) as *Androctonus* (*Leiurus*) *leptochelys*. Since its creation, *Buthacus* has been considered a subgenus or a genus by different authors. It was finally validated as a genus by Vachon (1949; 1952).

According to the recent assessment, Algeria contains about 30% of *Buthacus* species in the world (Rein, 2022) and all these species are found in the arid regions including deserts (Lourenço, 2006, 2013; Lourenço & Sadine, 2015; Lourenço *et al.*, 2016, 2017; Sadine, 2018b). The present survey aims to summarize the list of *Buthacus* species in central Algeria (Ghardaïa) one of the important areas in scorpion biodiversity and endemic species in Algeria (Sadine, 2018b).

Material and Methods

Study area

The region of Ghardaïa is located in the Central of Algeria (Fig. 1) and covers a total area of 86,560 km^2. The average altitude of the main reliefs is of 520 meters. Geomorphological features are constituted by the Regs and Ergs (Benkenzou *et al.*, 2007). The region is characterized by a dry Saharan climate with extreme thermal amplitudes between the day and the night, reaching 15-16 degrees (Sam, 2012). The coldest month is January with a minimal temperature of 6.2°C, whereas the hottest month is July with a maximum temperature of 41.8°C.

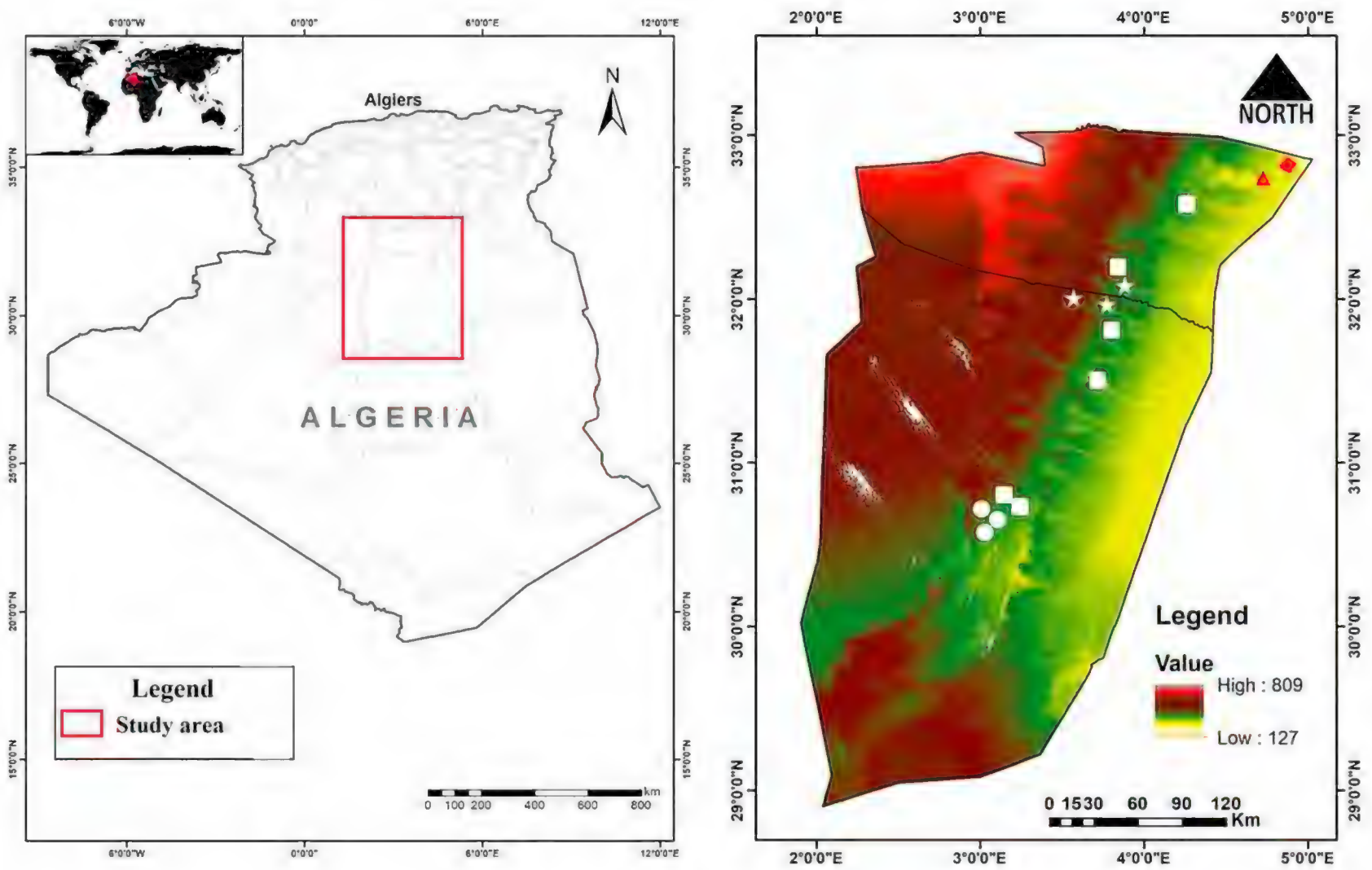

Fig. 1. Map of Algeria showing the study area and the repartition of *Buthacus* species: *B. arenicola* (red triangle), *B. birulai* (red rhombus), *B. elmenia* (white circle), *B. samiae* (white square), and *B. spinatus* (white star).

Rain fall is extremely low in the region of Ghardaïa with an average value of 80.2 mm per year. Air humidity is rather weak with a maximum value of 55.5% in December and a minimum of 21.6% in July (Chehma, 2011). Analysis of dry periods over several years attest that 11 months are dry ranging from February to December; only a short and slightly more humid period can be experienced in January (Sadine *et al.*, 2016).

Sampling and identification of scorpion

The specimens of *Buthacus* were collected at night with U.V light detection in sandy areas (Erg, Reg with sand). Specimens were killed and kept in 70% alcohol. Identification was obtained using a stereo-microscope as described by Vachon (1974). Material is deposited in Laboratory of Zoology, University of Ghardaïa, Algeria.

Results and Discussion

Check-list of the *Buthacus* species recorded in Algeria (in order of discovery)

B. arenicola (Simon, 1885)
B. foleyi Vachon, 1948
B. leptochelys algerianus Lourenço, 2006 = *B. ziegleri* Lourenço, 2000
B. birulai Lourenço, 2006
B. armasi Lourenço, 2013
B. samiae Lourenço & Sadine, 2015
B. spinatus Lourenço, Bissati & Sadine, 2016
B. elmenia Lourenço & Sadine, 2017
B. ahaggar Lourenço, Kourim & Sadine, 2017

Taxonomic list of *Buthacus* scorpion in central Algeria

During 12 months of 2021, the field study was conducted to identify 5 species of *Buthacus*. The list of species is detailed as bellow.

Buthacus arenicola (Simon, 1885)

Scorpion of 50-60 mm in size. Colouration yellowish to pale yellow (Vachon, 1952) (Fig. 2, Table. 1). In many studies, this species was reported in Algerian Northern Sahara (Sadine *et al.*, 2011; Sadine, 2012, 2018b; Sadine *et al.*, 2018), while Lourenço (2006) mentioned this species in Biskra region (North east of Algeria). In our study area, Vachon (1952) has examined a scorpion material from the El-Goléa region and Sadine *et al.* (2014) cited this species in Erg and sandy Regs of Ghardaïa (central Algeria) (Fig. 7A).

Fig. 2. Adult *Buthacus arenicola* (alive) in laboratory.

Buthacus birulai Lourenço, 2006

Scorpions of moderate to large size with a total length of 57 mm in males and 62 mm in females (Fig.3, Table 1). General colouration yellowish to pale yellow without spots (Lourenço, 2006). In his general revision of *Buthacus* species, Lourenço has examined a material from El-Oued Eastern Algerian (Lourenço, 2006). In the present study, this species was sampled with one specimen in East part of Ghardaïa region (Central Algeria) (Fig. 7A). It is considered as a new locality for this species outside its known range.

Fig. 3. Adult *Buthacus birulai* (alive) in laboratory.

Buthacus elmenia Lourenço & Sadine, 2017

Scorpions of moderate size with a total length of 40.7 mm for adult female (Fig. 4, Table.1), general colouration yellow to pale yellow without spots in adults (Lourenço *et al.*, 2017). In current study, we sampled only one female adult with a total length of 50.2 mm near the type locality, El-Goléa. In this locality, we found many juveniles their identification is very difficult.

Fig. 4. Adult *Buthacus elmenia* (dead) in laboratory.

Buthacus samiae Lourenço & Sadine, 2015

Scorpion with medium size (50-60 mm), general colouration yellow to pale yellow (Lourenço & Sadine, 2015) (Fig. 5, Table 1). The species was described from Ghardaïa Erg. It was recently found in Ouargla Erg, more than 200 km east of the type locality (Sadine *et al.*, 2018). In this work, *B. samiae* expanded its range to the south of our study area and it was found in co-habitation with *B. elmenia*, while, it cohabits with *B. spinatus* in the North.

Fig. 5. Adult *Buthacus samiae* recently sampled.

Buthacus spinatus Lourenço, Bissati & Sadine, 2016

Small *Buthacus* (27-28 mm), yellow to pale yellow with dark brown to blackish metasomal segment V (Lourenço *et al.*, 2016) (Table 1). This species seems rare and only one juvenile specimen was sampled in our survey (Fig. 6). We note that this species can be found in Erg and sandy Reg.

Fig. 6. Juvenile *Buthacus spinatus* recently sampled.

The list of *Buthacus* species from Central Algeria regroups 5 psammophilous species, with medium size except *B. spinatus* (smaller *Buthacus*). The table below summarizes some morphological values and biotope affinity of *Buthacus* species inventoried in our study area.

Table 1. Morphological comparison of *Buthacus* species inventoried in the Ghardaïa region (Central Algeria).

Species	Total length (mm)	Pectinal teeth		Rows of granules	Biotope margin
		♂	♀		
B. arenicola	50-60	/	23-25	8-9	Erg
B. birulai	57-62	/	29-29	9-10	Erg
B. elmenia	50.2	/	16-17	7-8	Erg
B. samiae	55-57	28-32	24-26	8-9	Erg/Reg/Wadi-bed
B. spiantus	27-28	/	21-22	7-8	Erg/Wadi-bed

All studied *Buthacus* species are rare and very attached to their biotopes (Fig. 7) except *B. samiae* which is the most abundant and widespread species in Central Algeria. We report here that the males are very rare for *Buthacus* species in this region. The same remark has been reported in Ouargla and El-Oued (Sadine, 2005; Sadine, 2012).

This list represents more than 55% of Algerian *Buthacus* and attests to a very important diversity estimated more than 16% of the world's known *Buthacus* species (Rein, 2022) and qualifies the Central Algeria (Ghardaïa) as a biodiversity hotspot.

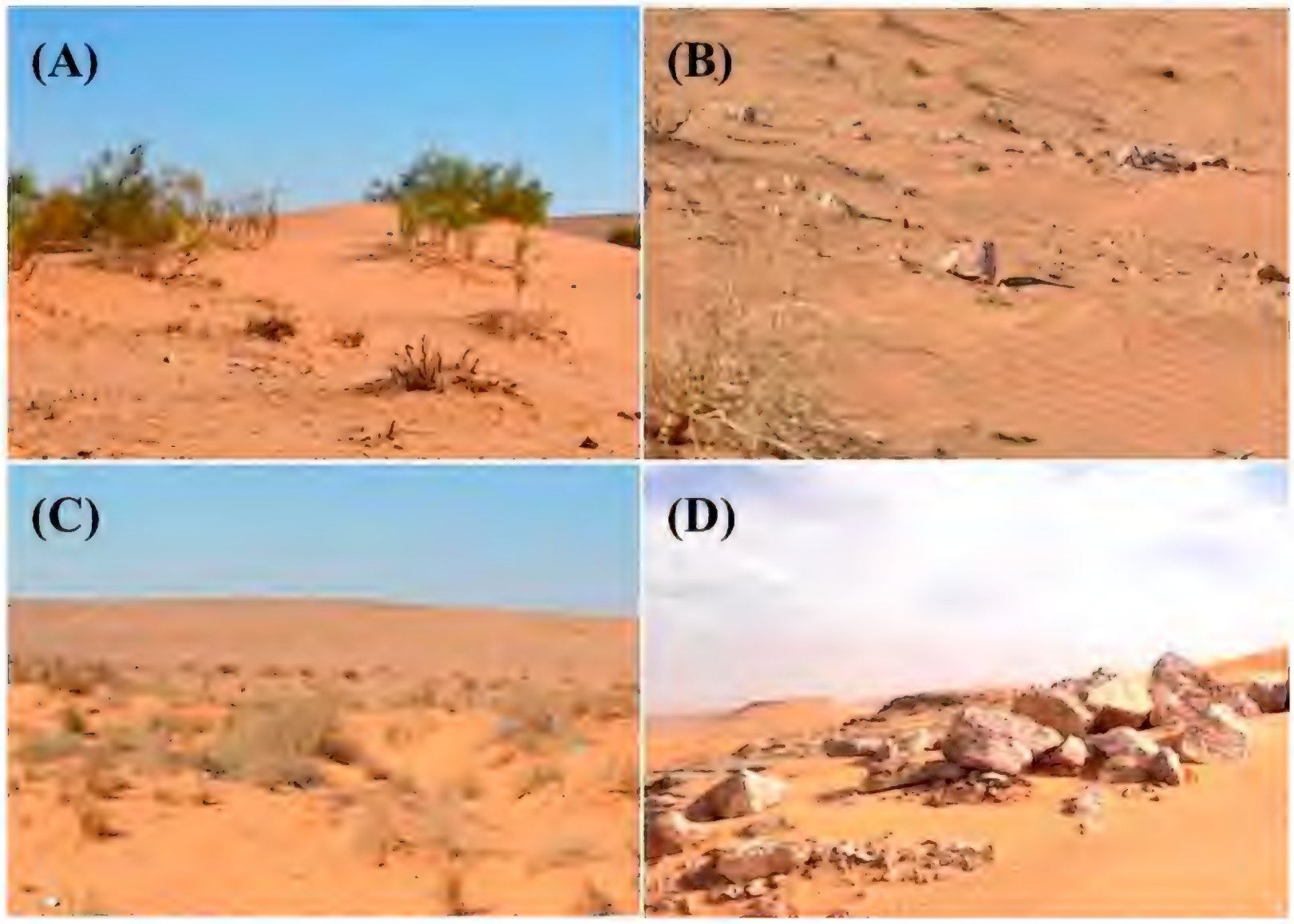

Fig. 7. Natural habitats of *Buthacus* species in Ghardaïa region (Central Algeria): A. Habitat of *B. arenicola* and *B. birulai*. B. Habiat of *B. samiae*. C. Habitat of *B. spinatus*. D. Habitat of *B. elmenia*.

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First record of the genus *Nita* Huber & El-Hennawy, 2007 (Araneae: Pholcidae) from Algeria

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Abstract

In this study, the new discovery in Algeria of the monotypic genus *Nita* Huber & El-Hennawy, 2007 through the species *Nita elsaff* Huber & El-Hennawy, 2007 is presented. Different views of the female habitus as well as the epigyne are presented. This new record from the Algerian Sahara is considered to be the most western point of the species distribution.

Keywords: Araneae, *Nita elsaff*, Northern Sahara, species range, palm grove, Algeria.

Introduction

The family Pholcidae C.L. Koch, 1850 counts widely 1876 species belonging to 97 genera (World Spider Catalog, 2022). In Algeria this family is known by nine species under six genera from different localities in the country, namely: *Artema atlanta* Walckenaer, 1837 from In Salah and Tamanrasset (Denis, 1954) and Djanet (Aharon et *al*., 2017), *Crossopriza illizi* Huber, 2022 from only its locality Illizi (Huber, 2022), *Holocnemus pluchei* (Scopoli, 1763) from Algiers, Annaba, El Kala, Mostaganem and Oran (Lucas, 1846), from Boumerdes (Simon 1874), Algiers (Simon, 1899), Ain Témouchent (Strand, 1908), Mila (Denis, 1937) and from Algiers and Médéa (Huber, 2022), *Holocnemus reini* (C. Koch, 1873) from Batna, Biskra, Blida, M'sila, Sétif and Sidi Bel Abbès (Huber, 2022), the newly discovered *Maghreba nkob* Huber, 2022 known in Algeria from Bechar (Huber, 2022), the endemic *Pholcus genuiformis* Wunderlich, 1995 from Algiers, Boumerdes and Tlemcen (Wunderlich, 1995) and Msila (Huber,

2011), the endemic *Pholcus mecheria* Huber, 2011 from Naama and Msila (Huber, 2011), *Pholcus phalangioides* (Fuesslin, 1775) from Algiers, Annaba and Constantine (Lucas, 1846), Bejaia and Tipasa (Simon, 1910) and finally *Spermophora senoculata* (Dugès, 1836) from Constantine (Lucas, 1846) and Mila (Denis, 1937).

The male and female of *Nita elsaff* Huber & El-Hennawy, 2007 were described for the first time by Huber and El-Hennawy (2007) in their remarkable paper on the subfamily Ninetinae. The species was recorded from Egypt and Uzbekistan. Later, the male of *N. elsaff* was reported from Iran (Zamani *et al.*, 2017), and recently by male and females from Iraq (Baker *et al.*, 2019).

In this paper, *N. elsaff* is recorded for the first time in Algeria from a locality in the Sahara Desert.

Material and Methods

Study area

The region of Ghardaïa is located at 600 km to the South of Algiers, in the North-western part of the Sahara (32°29'N, 3°40'E). Ghardaïa supports various Saharan environments and biotopes: rocky ridges, Dayas, Regs and parts of the Western Erg (Alioua *et al*, 2022). Ghardaïa's climate is hot, arid and characterized, for the year of 2021 for example, by an average annual temperature of 23.8°C, and rainfall of 35.56 mm while winds reached an average annual speed of 13.0 km/h (Tutiempo, 2022).

Berriane is located at 45 km to the North of Ghardaïa, it is known for its palm grove grown along the Wadi of Balouh. The area supports various agricultural activities inside its palm grove.

Abbreviations

CYA: Collection Youcef Alioua.
ZFMK: Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany.

Sampling

The individual of *N. elsaff* was collected during a spider inventory study conducted in 2021, it was captured directly by hand collecting on vegetation and soil in Berriane. The collected materiel was preserved in 70% ethanol. A stereomicroscope Nikon SMA 1270 was used for examination and a Moticam camera mounted on a Relaux microscope and Olympus SZX7 stereomicroscope for photographing.

Results

Nita Huber & El-Hennawy, 2007
Nita elsaff Huber & El-Hennawy, 2007
Nita elsaff Huber & El-Hennawy, 2007: 46, figs. 1-16 (descr. ♂♀); Zamani *et al.*, 2017: 65, figs. 5A-D; Baker, Ali & Fadhil, 2019: 405, pl. 1A-C.

Type material

Holotype ♂ from El Saff (29°57'N, 31°28'E), Giza, Egypt; March 1, 2003 (M. Mohafez), in ZFMK (Ar 005).

New material examined (Fig. 1)

ALGERIA: ***Ghardaïa Province***: Berriane (32°50'41.39" N 3°43'27.56" E), 544 m a.s.l, 1 ♂, palm grove, 16 April 2021 (CYA).

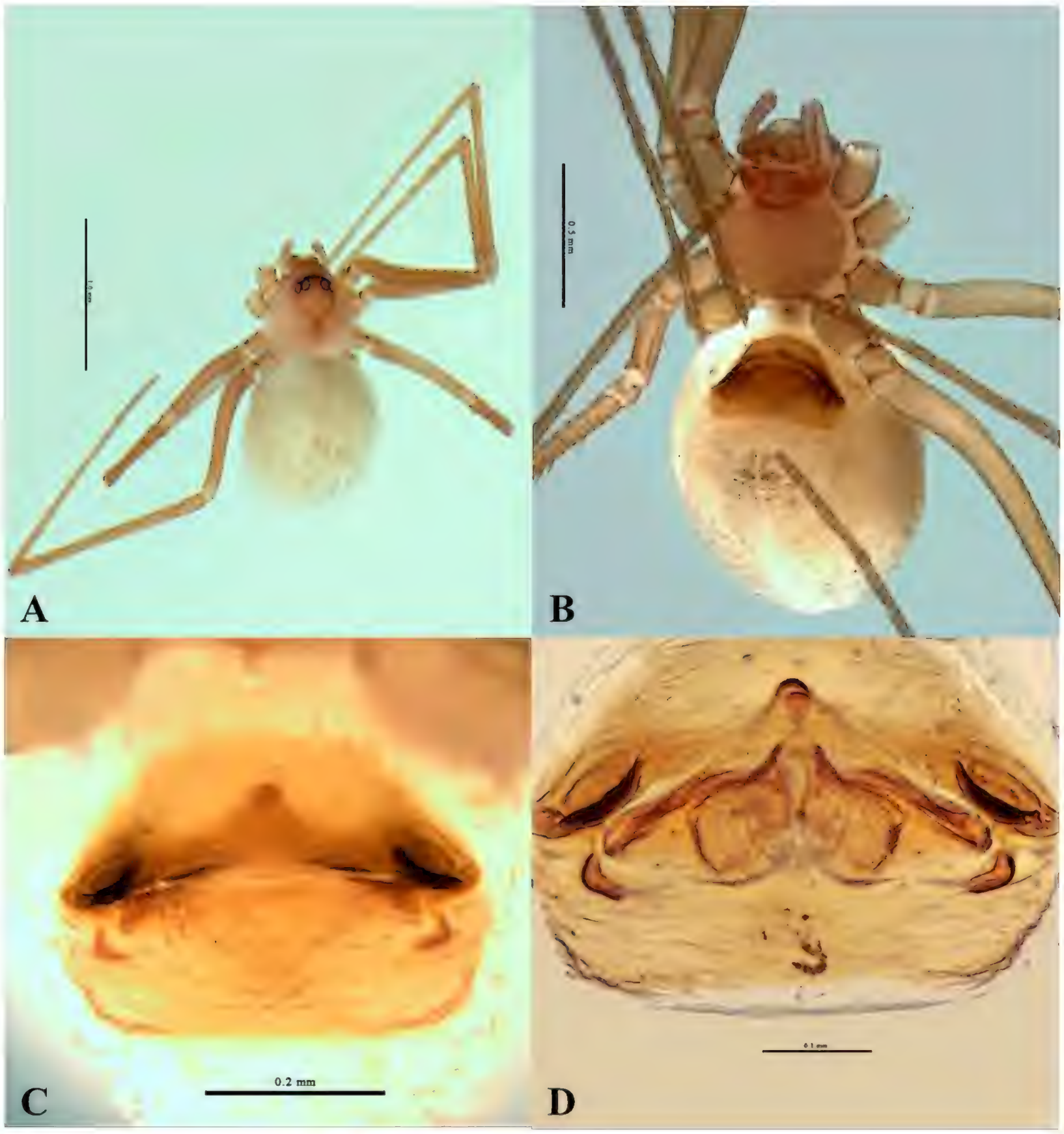

Fig. 1. Female of *Nita elsaff* from Ghardaïa: A. dorsal view. B. ventral view. C. epigyne. D. vulva. (Scale lines: A: 1 mm, B: 0.5 mm, C: 0.2 mm, D: 0.1 mm).

Description

Female: Total length 1.71 mm; carapace 0.59 mm long, 0.63 mm wide.

The female is generally pale ochre-yellow, carapace with narrow median light brown stripe widening frontally to cover ocular area, abdomen monochromous grey. Ocular area slightly elevated; thoracic furrow present, indistinct and shallow. Clypeus unmodified. with distinctive pair of pockets and internal structures visible through cuticle (Huber & El-Hennawy, 2007).

Comments

The species was only described recently from Egypt and Uzbekistan (2007) but was rapidly recorded in other countries as well. Few years later it was also recorded in Iran (Zamani *et al*., 2017) and Iraq (Baker *et al*., 2019). Is this species rapidly dispersing or has it been overlooked in the past? In this paper we present the first record of the genus *Nita* in Algeria and the second for Africa. *N. elsaff* was captured in the Saharan part of

the country, in Berriane, on low vegetation inside the well irrigated palm groove of the river bed of Balouh. This record is another large extension of its distribution area and is now the most western point of the known distribution of the species (Fig. 2).

Fig. 2. Distribution of *Nita elsaff* (circles: previous records, rectangle: new record).

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Intraguild predation on hornets and yellowjackets of vespine wasps by spiders, and vice versa

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Abstract

Not only spiders (Arachnida: Araneae) but also vespine wasps (Hymenoptera: Vespidae: Vespinae) including hornets (the genus *Vespa*) and yellowjackets (the genera *Vespula* and *Dolichovespula*) belong to top-predator community within arthropod food webs. Thus, between two communities, intraguild predation (IGP) defined as killing and eating among potential competitors is considered to occur. However, the possibility has not investigated enough so far. In the present study by means of bibliographic survey it has been reported that the observations of predation on *Vespa*, *Vespula*, and *Dolichovespula* of vespine wasps by spiders; i.e., large web-building spider *Argiope* spp. (Araneidae) captured *Vespa orientalis*, *A. amoena* and *A. bruennichi* fed on hornets *V. analis*, jumping spiders such as *Phidippus audax* (Salticidae) preyed on yellowjackets (*Vespula germanica*, *Dolichovespula maculate*, and *D. arenaria*), a tunnel web spider *Porrhothele antipodiana* (Mygalomorphae) consumed *Vl. germanica*, orb-weavers *A. aurantia* and *A. florida* captured *Vl. squamosa*, diet of wandering spider *Phoneutria boliviensis* (Ctenidae) contained *Vespula* sp. By contrast, 20 cases were that vespine wasps foraged spiders from 10 publications with certain species names. Accordingly, symmetric IGP between vespine wasps and spiders is suggested. Observations on kleptoparasitism by hornets, an escaping from a spider's web by a vespulid wasp, and a killing between a spider and a yellowjacket each other were also known. Although spiders are both prey and predators of vespine wasps, further studies are required to elucidate quantitatively the interaction of prey-predator relationship as symmetric IGP.

Keywords: Araneae, Diet, Food Chain, IGP, Predator-Prey Relationships, Vespinae.

Introduction

Spiders (Arachnida: Araneae), one of ubiquitous predators in terrestrial ecosystems (Wise, 1993), are constituting a community as a top-predator species among arthropods (e.g., Schmitz & Suttle, 2001). In fact, as quantitatively, an annual prey kill of the global spider community has in the range of 400-800 million metric tons, with insects and collembolans (Nyffeler & Birkhofer, 2017). Meanwhile, as another usual top-predators of a wide variety of arthropod prey like insects, most species of the subfamily Vespinae (Hymenoptera: Vespidae), containing the largest and best-known eusocial wasps of true hornets (the genus *Vespa*), yellowjackets (the genera *Vespula* and *Dolicovespula*) and nocturnal hornets (the genus *Provespa*), inhabiting mainly Eurasia, North Africa, North America and Oceania, have been also recognized (e.g., Richards, 1971; Matsuura & Yamane, 1990; Matsuura, 1991; Richter, 2000). Though in vespine wasps it is revealed that they are consisting of a community as a top-predator species among arthropods (e.g., New, 2016), it seems that the impact of them has not been studied quantitatively enough yet compared with spiders.

Because both spiders and vespine wasps are commonly known as generalist/semi-specialist predator community with some exceptions (e.g., Foelix, 2011; Matsuura, 1991; Wise, 1993), predation with each other occur occasionally in areas where their habits overlap. Matsuura (1984), for example, has described that vespine wasps sometimes feed "Araneae" and Miyashita & Shinkai (1995) have reported that a part of the diet of large orb-web spiders was composed "Hymenoptera". Regrettably, these species of prey-items were characterized by only their order level. If more certain species names of them are available, the relationship between spiders and vespine wasps would be expected to strongly demonstrate as "Intraguild predation (IGP)" in ecosystems based on precise scientific observations in detail.

Intraguild predation (IGP) is defined as killing and eating among potential competitors, appearing to be pervasive within arthropod food webs, with frequencies of 58-87% (e.g., Yasuda, 1996; Arim & Marquet, 2004; Hunter, 2009; Schowalter, 2016). Here, a guild is defined as a group of species that exploit the same class of environmental resources in a similar way (Root, 1967). Generally, asymmetric IGP occurs when one species (A, by convention) has been always the predator on B, whereas symmetric IGP occurs during mutual predation between A and B (Polis *et al.*, 1989). IGP could be important because it reduces predation pressure on vegetative predators, adds redundancy to simple trophic cascades and increases ecosystem stability (Polis & Holt, 1992; Holt & Polis, 1997; Finke & Denno, 2005).

Note that it has been hypothesized that predators deliberately engage in IGP for the nutrients of another predator (Matsumura *et al.*, 2004; Michalko *et al.*, 2021). Within spiders (Hodge, 1999) and Hymenoptera (Feldhaar, 2011) of IGP and a possibility that wasps prey spiders as IGP were studied before (Crowder & Snyder, 2010). The relationship may be nutritionally of significance, even if the amount of predation on each other is small for spiders and vespine wasps. Nevertheless, studies on the prey-predator relationship between spiders and vespine wasps as IGP are few as far. How much is known about the predation on vespine wasps by spiders, and vice versa? One of the authors previously reported exact such cases; i.e., *Argiope amoena* and *A. bruennichi* preyed on *Vespa analis insularis* in Fig. (1) (Noguchi, 2020; 2021), which remained sporadic records. Perhaps, observational cases on vespine wasps prey spiders, and vice versa, were reported independently without summarizing comprehensively.

Fig. 1. Observations of *Argiope amoena* (left) and *Argiope bruennichi* (right) feeding on *Vespa analis* (Noguchi, 2020, 2021).

To the best of our knowledge, there seems to be no comprehensive overview of observed cases of predation on vespine wasps by spiders, and vice versa. Therefore, we searched scientific research articles regarding observational cases of predation among spiders and vespine wasps each other with a viewpoint of symmetric/asymmetric IGP around the world to achieve a fundamental step for convenience.

Material and Methods

Firstly, we have checked books dealing with the biology of vespine wasps such as "The biology of the social wasps (Hymenoptera, Vespidae)" (Richards, 1971), "Wasps: An account of the biology and natural history of social and solitary wasps" (Spradbery, 1973), "Biology and pest status of venomous wasps" (Akre & Davis, 1978), "Social wasps" (Akre, 1982), "Biology of the vespine wasps" (Matsuura & Yamane, 1990), "*Vespa* and *Provespa*" (Matsuura, 1991), "Social wasp (Hymenoptera: Vespidae) foraging behavior" (Richter, 2000), "Wasps" (Schmidt, 2009), "Individual and social foraging in social wasps" (Jeanne & Taylor, 2009), and "Enemies of wasps subverting the sting" (Eaton, 2021). Then, we searched papers on Google Scholar by the keywords like "hornet", "yellowjacket", "vespine wasps" combined with "spider", "Araneae", "predation" and "feed".

Results

An escape of *Vespula germanica*, not a hornet but a yellowjacket, caught in spider webs was reported by Fordham (1961). This finding seems to be the only case of escaping successfully from spider webs by a vespulid documented so far. It has been known that insects have evolved a variety of anti-predator defences in predator-prey relationships (e.g., Sugiura, 2020). Sugiura *et al.* (2019) reported that when mantids were placed in the web of *A. bruennichi*, some mantids could use their mouthparts to escape

from the spider silk wrapped around their forelegs. While, other mantids were fed on by the spiders resulting in the failure to escape. Consequently, it was hypothesized that the escape from spider webs may be also observed in other insects with powerful mouthparts (e.g., hornets) by means of further observations and experiments.

It is summarized in Table (1) that research articles where general remarks, belonged to genera of spiders had not determined, regarding prey-predation interactions between vespine wasps and spiders were described. The prey of *Vespa mandarinia* in the field were mainly large caterpillars and large web-building spiders (Matsuura & Sakagami, 1973). *Vespula flaviceps* foraged on spiders (Iwata, 1971). *Vespula consobrina* captured small spiders (Akre *et al.*, 1982). *Vespa analis* and *Vespa simillima* fed on spiders (Matsuura, 1984). *Vespula pensylvanica* preyed on Araneae (Gambino *et al.*, 1987; Wilson *et al.*, 2009) and Philodromidae (Wilson *et al.*, 2009). *Vespula vulgaris* preyed on Araneae and Salticidae (Broekhuizen & Hordijk, 1968; Harris, 1991; Harris & Oliver, 1993).

Lycosidae, Sparassidae, and Argiopidae [The now suppressed familial name for Araneidae] (Madden, 1981), Araneae and Salticidae (Harris, 1991; Harris & Oliver, 1993; Harris, 1996) and spiders (Sackmann *et al.*, 2000) were preyed on by *Vl. germanica*. Foraging by *Vl. germanica* can cause localized drastic reductions in spiders (Spradbery & Maywald, 1992; Donovan, 1992). Meanwhile, the proportion of spiders in the diet of *Vl. germanica* was small depending on conditions (Kasper *et al.*, 2004). *Agelenopsis aperta* (Agelenidae) may prey on Vespidae (Riechert, 1991).

Table 1. The cases of the predator-prey relationships of vespine wasps and spiders by means of general description.

Predators	Prey	References
V. mandarinia	large web-building spiders	Matsuura & Sakagami, 1973
V. analis	spiders	Matsuura, 1984
V. simillima	spiders	Matsuura, 1984
Vl. vulgaris	Araneae and Salticidae	Broekhuizen & Hordijk, 1968; Harris, 1991; Harris & Oliver, 1993
Vl. flaviceps	spiders	Iwata, 1971
Vl. consobrina	small spiders	Akre *et al.*, 1982
Vl. pensylvanica	Araneae	Gambino *et al.*, 1987; Wilson *et al.*, 2009
	Philodromidae	Wilson *et al.*, 2009
	Lycosidae Sparassidae Argiopidae (= Araneidae)	Madden, 1981
Vl. germanica	Araneae and Salticidae	Harris, 1991; Harris & Oliver, 1993; Harris, 1996
	spiders	Spradbery & Maywald, 1992; Donovan, 1992; Sackmann *et al.*, 2000; Kasper *et al.*, 2004
Ag. aperta	Vespidae (potential prey)	Riechert, 1991

Articles with detailed statements containing scientific names of species and/or genera of both vespine wasps and spiders as predators/prey are as follows: Matsuura & Yamane (1990) summarized several observations of vespine wasps predation on spiders (Table 2); *Vespa mandarinia* preyed on *A. amoena* and *A. bruennichi* (Araneidae,

respectively) (Matsuura, 1984); *Vespula vulgaris* preyed on spiders such as *Philodromus* sp. (Philodromidae) [in the original article, classified as Thomisidae], *Trochosa* sp. (Lycosidae), *Theridion ovatum* (Theridiidae), *Meta segmentata* (Argiopidae) [= *Metellina segmentata* of Tetragnathidae], *Linyphia triangularis* and *Drapetisca socialis* (Linyphiidae) (Broekhuizen & Hordijk, 1968).

Table 2. The cases of the predator-prey relationships of spiders and vespine wasps by means of detailed description with scientific names of species and/or genera.

Predators	Prey	References
V. mandarinia	*A. amoena* *A. bruennichi*	Matsuura, 1984
Vl. vulgaris	*Philodromus* sp. *Trochosa* sp. *Th. ovatum* *M. segmentata* *L. triangularis* *D. socialis*	Broekhuizen & Hordijk, 1968

The followings are reported cases found in literature searches by Google Scholar: *Eriophora pustulosa* (Gibbs, 1980) and *Zygiella x-notata* (Pasquet *et al.*, 2007) (Araneidae) were preyed on by *Vl. germanica*. *Vespa* sp. took *Trichonephila clavata* away (Miyashita, 1994). *Vespula vulgaris* preyed on *Er. pustulosa* (Toft & Rees, 1998; Lester & Beggs, 2019). *Vespula pensylvanica* preyed on Araneae of the genera of *Cheiracanthium* sp. (Cheiracanthiidae), *Vespa affinis* captured *Cyclosa confusa* (Araneidae) (Chou *et al.*, 2005). *Habronattus* (Salticidae), *Achaearanea*, *Theridion* (Theridiidae, respectively) and *Mecaphesa* (Thomisidae) (Wilson *et al.*, 2009). *Vespa crabro* preyed on *A. bruennichi* (Helsdingen, 2011; Bruggisser *et al.*, 2012). These cases of yellowjackets fed on spiders with certain species names from above are in Table (3).

Tunnel web spider *Porrhothele antipodiana* (Mygalomorphae: Porrhothelidae) captured *Vl. germanica* (Laing, 1973). *Vespa orientalis* wasps were captured by *Argiope* spp. (Hendawy, 2004). *Argiope aurantia* and *A. florida* preyed on *Vespula squamosa* (Carrel & Deyrup, 2019). By virtue of one of the authors' observations, *A. amoena* (Noguchi, 2020) and *A. bruennichi* (Noguchi, 2021) preyed on *V. analis*. DNA metabarcoding analysis revealed that *Vespula* sp. was one of the diets of wandering spider *Phoneutria boliviensis* (Ctenidae) (Ramírez *et al.*, 2021). These reported cases are shown in Table (4).

About 100 years ago, several observed cases regarding the prey-predator relationship between vespine wasps and spiders had been reported (Bilsing, 1920). *Vespula germanica*, *Dolichovespula arenaria* and *D. maculata* [in the original article, stated as *Vespa germanica*, *Vespa diabolica* and *Vespa maculata*] were foraged by *Phidippus audax* (Salticidae [in the original article, stated as Attidae]); *D. arenaria* was preyed by *Neoscona domiciliorum* (Araneidae) [in the original article, stated as *Epeira domiciliorum*]; *Vl. germanica* was fed on by *Hogna carolinensis* (Lycosidae) [in the original article, stated as *Lycosa carolinensis*], *Araneus trifolium* [in the original article, stated as *Epeira trifolium*], *Epeira gigas* [= *Araneus bicentenarius*] and *Argiope trifasciata* (Araneidae). These cases, observed in field or cage, are shown in Table (5).

Table 3. Cases of hornets and yellowjackets preyed on spiders with species and/or genera names were shown.

Predators	Prey	References
Vl. germanica	*Er. pustulosa*	Gibbs, 1980
	Z. x-notata	Pasquet *et al.*, 2007
Vespa sp.	*T. clavata*	Miyashita, 1994
Vl. vulgaris	*Er. pustulosa*	Toft & Rees, 1998; Lester & Beggs, 2019
V. affinis	*C. confusa*	Chou *et al.*, 2005
Vl. pensylvanica	*Cheiracanthium* sp. *Habronattus* sp. *Theridion* sp. *Achaearanea* sp. *Mecaphesa* sp.	Wilson *et al.*, 2009
V. crabro	*A. bruennichi*	Helsdingen, 2011; Bruggisser *et al.*, 2012

Table 4. Cases of hornets and yellowjackets preyed by spiders, both species and/or genera names were shown.

Predators	Prey	References
Po. antipodiana	*Vl. germanica*	Laing, 1973
Argiope spp.	*V. orientalis*	Hendawy, 2004
A. aurantia *A. florida*	*Vl. squamosa*	Carrel & Deyrup, 2019
A. amoena	*V. analis*	Noguchi, 2020
A. bruennichi	*V. analis*	Noguchi, 2021
Ph. boliviensis	*Vespula* sp.	Ramírez *et al.*, 2021

In addition, studies on observed cases of kleptoparasites by a vespine wasps caught in spider webs are shown. *Vespula germanica* preyed on a hover-fly that was caught in a spider web (O'Rourke, 1945). Workers of *Vespa mongolica* [now a subspecies of *V. simillima*] have been seen removing workers of *Vespa* spp. from spider webs (Iwata, 1971; Akre, 1982). *Vespa affinis* attacked prey in the web of *C. confusa* (Chou *et al.*, 2005). *Vespa crabro* has been reported to steal and feed on the web prey of the spiders: *Argiope aurantia* (Davis, 2011) and *A. bruennichi* (Helsdingen, 2011).

Interactions of not exact predator-prey relationships such as offence or defence were also reported. Once, a case of killing each other at the same time between *Tegenaria atrica* and *Vl. germanica* was reported (Scott, 1930). A founders of *V. analis* were found to capture and dump a spider approaching her nest (Yamane & Makino, 1977).

Table 5. The Cases of predation on yellowjackets (the genera *Vespula* and *Dolichovespula*) by spiders (Bilsing, 1920).

Predators	Prey	Reference
Ph. audax	*Vl. germanica* *D. arenaria* *D. maculata*	Bilsing, 1920
H. carolinensis *Ar. trifolium* *Ep. gigas* *A. trifasciata*	*D. arenaria*	

Discussion

It is found from the results above that predator-prey relationships between vespine wasps and spiders, and vice versa, have not been studied enough yet quantitatively. Compared with the reported cases of predation on spiders by vespine wasps, there have been fewer cases of predation on vespine wasps by spiders. In spite that predation on spiders by vespine wasps is relatively more common in the observational records characterized within the species and/or the genera level, it may not have been investigated exhaustively in the habitats. The cases of predation on vespine wasps by spiders which could be found are reported by only five references (Bilsing, 1920; Laing, 1973; Hendawy, 2004; Carrel & Deyrup, 2019; Ramírez *et al.*, 2021) excepting for the research articles by one of the authors (Noguchi, 2020; 2021), suggesting that these observations remain very fragmentary with considering their actual interactions in the global ecosystem. As observed by Fordham (1961), predation on vespine wasps by spiders might be prevented by escaping from spider webs using the powerful mouthparts of vespine wasps like mantids did (Sugiura *et al.*, 2019). One possible reason for the records remaining fractional could be supposed that predation on vespine wasps by spiders has not been well documented by wasp's researchers, because they were simply not familiar with spiders, or they overlooked the ecological importance of the predator-prey relationships among them. Besides, it may also be due to the fact that prey of spiders has been difficult to be investigated within the species level.

Otherwise, among the conditions constituting IGP, the cases of "predation on predators by predators" have been found to occur not limited to specific areas at least qualitatively. Spiders have been shown to have different trophic levels among taxa and developmental stages based on the characteristics of $\delta^{15}N$ (Sanders *et al.*, 2015), on the other hand, there may be still a possibility that predation does not occur depending on the levels of species of spiders. It would be possible that asymmetric IGP between spiders and vespine wasps, which differ in relative body sizes each other. And the possibility of symmetric IGP between large-sized spiders and vespine wasps may be suggested by the observations that *V. analis* and *Argiope* spp. feed on each other (Matsuura, 1984; Noguchi, 2020, 2021) and same as *Vl. germanica* and spiders (Tables 1, 3-5). So, "symmetric IGP" may be occurring at least between the hornet *V. analis* and argiopids and the yellowjacket *Vl. germanica* and several spiders. Although symmetric IGP is more common, body-sizes and developmental stages are often important factors (Polis *et al.*, 1989). In fully metamorphosed wasps, body-sizes and developmental stages are not factors in symmetric IGP; for this reason, this may be an unusual case and the frequency of this phenomenon has to be further investigated. Another condition for IGP is "habiting the same place in time and space" (Potter *et al.*, 2018), which spiders and vespine wasps seem to satisfy. But if flying vespine wasps in airborne, ambushing spiders in the web and wandering spiders in the ground are in the same guild, this would be considered a characteristic case.

It will be needed to gather further information on the prey-predatory relationship between vespine wasps and spiders more generally and in detail and be examined whether these relationships are equivalent to IGP. It should be also necessary to study what kind of diet of spiders are for vespine wasps in terms of quantity and quality, and vice versa. From a quantitative point of view, it would be of great importance to conduct a more detailed survey to determine the proportion of each diet items, as in such as Matsuura (1984) and Miyashita & Shinkai (1995). In recent years, DNA analysis of intestinal contents is also performed (e.g., Aebi *et al.*, 2011). For qualitative aspects, it may be required to conduct experiments by limiting the menu of prey items, or to verify ecochemometrics like Matsumura *et al.* (2004). Regrettably, it is not shown in the present

study, it would be also necessary to verify whether food resources are really shared in the same ecosystem between spiders and vespine wasps. Assuming the same ecosystem in Honshu, Japan, the captured prey items overlap well at the order level as the results of Matsuura (1984) and Miyashita & Shinkai (1995). Incidentally, the overlap at the species level is still unclear and should be investigated in more detail.

A total of 67 species of vespine wasps exists in the world (Carpenter & Kojima, 1997). According to the observational cases demonstrated above, predation on spiders by vespine wasps, and vice versa, there are only seven species of hornets of *V. affinis*, *V. analis*, *V. crabro*, *V. mandarinia*, *V. orientalis*, *V. simillima*, *V. velutina*, and eight species of yellowjackets of *Vl. consobrina*, *Vl. flaviceps*, *Vl. germanica*, *Vl. pensylvanica*, *Vl. squamosa*, *Vl. vulgaris*, *D. arenaria*, *D. maculate*. The predator-prey interactions between spiders and the remained 52 species (78%) of vespine wasps have not studied yet. Especially, there are only a few studies reported before about the cases of predation on yellowjackets (Bilsing, 1920; Laing, 1973; Carrel & Deyrup, 2019; Ramírez *et al.*, 2021) and hornets (Hendawy, 2004; Noguchi, 2020; 2021) by spiders having various types of predation; ambushing orb-weavers (Araneidae), jumping spiders (Salticidae), wandering spiders (Ctenidae and Lycosidae) and a tunnel web spider (Mygalomorphae: Porrhothelidae). Over a century, researchers have reported their observations on the prey-predation interaction between vespine wasps and spiders; however, there are only limited scientific articles shown herein to elucidate the whole ecological aspect regarding the symmetric IGP between vespine wasps and spiders. Hence, further research is essential in the future.

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A new species of *Oxyopes* Latreille, 1804 (Araneae: Oxyopidae) from Calicut University Campus, Kerala, India

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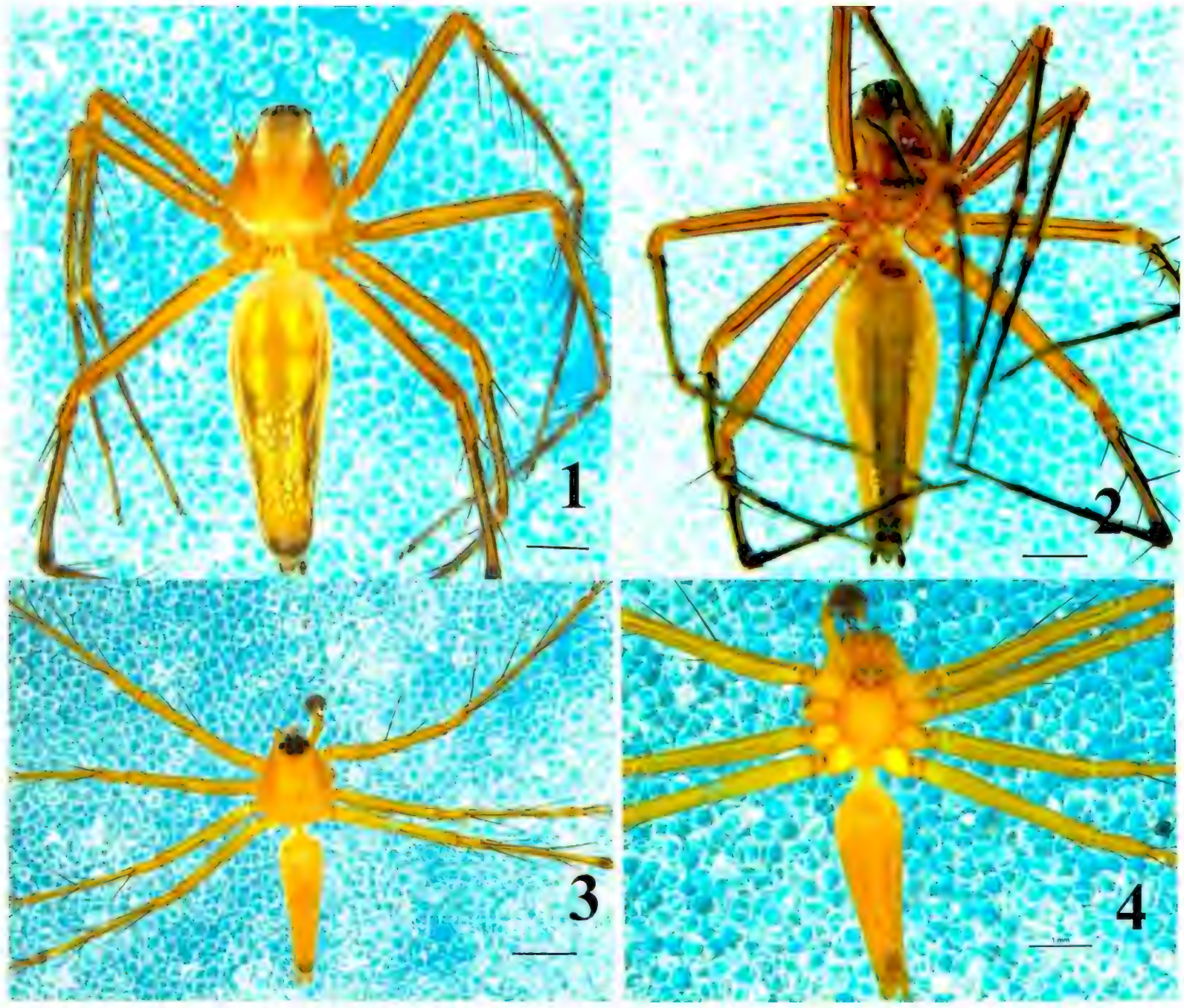
Abstract

A new species from the spider genus *Oxyopes* Latreille, 1804, *Oxyopes peetham* n. sp., is diagnosed and described from the Calicut University Campus, Kerala, India. A detailed morphological description, diagnostic features, and illustrations of the copulatory organs of both sexes of this new species are presented.

Keywords: Oxyopidae, *Oxyopes*, lynx spider, new species, description, Kerala, India.

Introduction

Members of family Oxyopidae are spiny legged hunting spiders which are capable of running very fast and jumping on their prey like a wild cat. Hence, they have got the name lynx spiders. Eight eyes arranged in hexagonal shape with wide clypeus and prominent spines on the legs are the general identifying features of this family. The lynx spider family Oxyopidae Thorell, 1869 is a small family comprising of nine genera and 443 species in the world; of which, 84 species under four genera viz., *Hamadruas* Deeleman-Reinhold, 2009, *Hamataliwa* Keyserling, 1887, *Oxyopes* Latreille, 1804, and *Peucetia* Thorell, 1869, have been reported from India (Gajbe, 2008; World Spider Catalog, 2022). While examining the spider collection from Calicut university campus, we came across a new species of the genus *Oxyopes* which is described and illustrated herein.



Figs. 1-4. *Oxyopes peetham* sp. n., Habitus. 1-2. Holotype Female. 3-4. Paratype Male. 1,3. dorsal view. 2,4. ventral view. (Scale bar: 1 mm).

Material and Methods

A mating pair (♂ & ♀) was collected from the Calicut university campus by handpicking. The specimens were directly transferred to 70% ethanol. The photographs and measurements were taken by using Leica M205C stereomicroscope, a Leica DFC450 Camera, and LAS software (Ver.4.12). Epigyne was dissected and cleared in 10% potassium hydroxide (KOH) solution for one day. Ocular measurements were taken, after placing the specimen, from the dorsal side. The left male pedipalp was dissected and photographed. Leg measurements are showed as: total length (femur, patella, tibia, metatarsus, tarsus). All measurements are in millimetres (mm). The studied specimens are deposited in the reference collection at the Centre for Animal Taxonomy and Ecology (CATE), Department of Zoology, Christ College (Autonomous), Irinjalakuda, Kerala, India.

Abbreviations used in the text and figures are as follows: AL = abdomen length, ALE = anterior lateral eye, AME = anterior median eye, AW = abdomen width, C = conductor, CD = copulatory duct, CL = cephalothorax length, CW = cephalothorax width, dRTA = dorsal retrolateral tibial apophysis, dTA = distal tegular apophysis, Em = embolus, FD = fertilization duct, MTA = median tegular apophysis, PLE = posterior lateral eye, PME = posterior median eye, S = spermatheca, SC = scape, SD = sperm duct, ST = subtegulum, T = tegulum, TL = total length, vRTA = ventral retrolateral tibial apophysis (Tang & Li, 2012; Baehr *et al.*, 2017; Lo *et al.*, 2021). Spination abbreviations: do = dorsal, pl = prolateral, rl = retrolateral, v = ventral.

Description

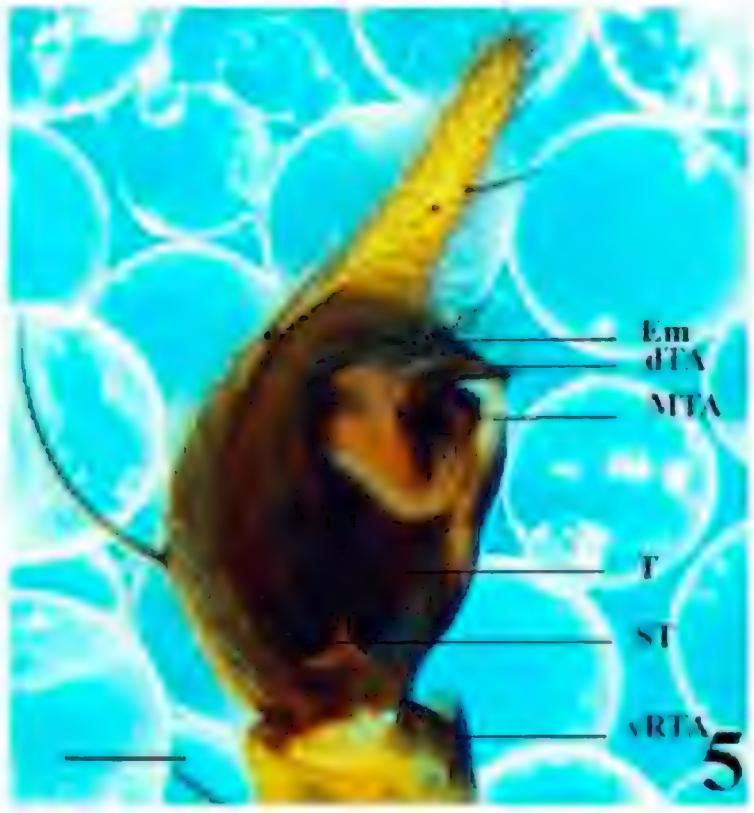
Family Oxyopidae Thorell, 1869
Genus *Oxyopes* Latreille, 1804
Type species *O. heterophthalmus* (Latreille, 1804)
Oxyopes peetham sp. n. (Figs. 1-14)

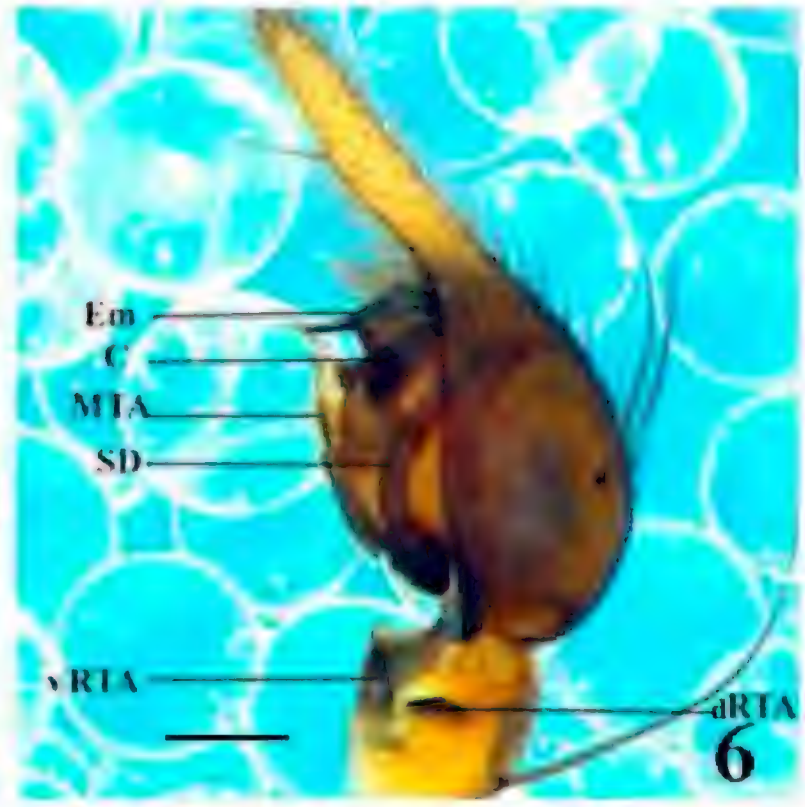
Material examined: 1♀ (Holotype) (CATE - 800494A), Kerala, Malappuram, Calicut University campus, (11.1340ºN, 75.8952ºE), 32 m a.s.l., 18.09.2021 K.B. Amulya. 1♂ (Paratype) (CATE - 800494 B), same data of the holotype.

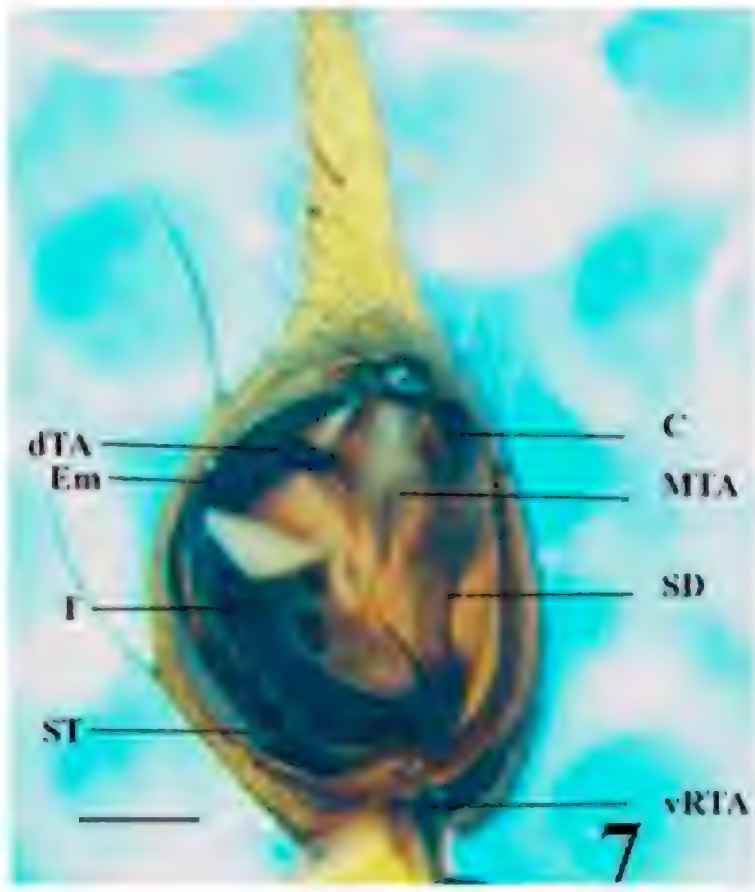
Etymology. The specific name is an adjective in Sanskrit that refers to the yellow coloured body in both sexes.

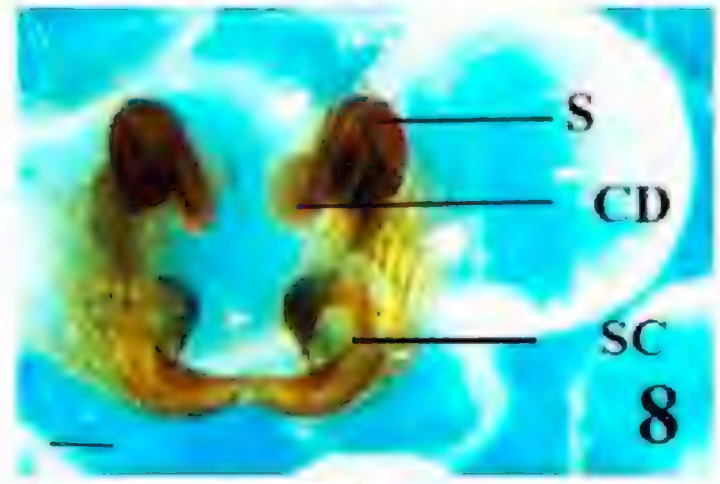
Diagnosis. *Oxyopes peetham* sp. n. somewhat similar to *O. bharatae* Gajbe, 1999 in epigyne morphology. It could be distinguished from the latter species by the following characters: i) copulatory duct eroteme shaped "?" in ventral view which is coiled into one turn towards the dorsal side and end to spermatheca (this turn absent in *O. bharatae*). ii) Male pedipalp having a prominent ventral tibial apophysis and a pitcher shaped median tegular apophysis. Median tegular apophysis triangular and less prominent in *O. bharatae*. iii) Embolus short and distinguishingly separated from the conductor. Embolus longer and covered with the conductor in *O. bharatae* [cf. figs. 27-30 (Gajbe, 1999), figs. 76-79 (Gajbe, 2008), plates 1A-D, 2A-B (Malik *et al.*, 2016)].

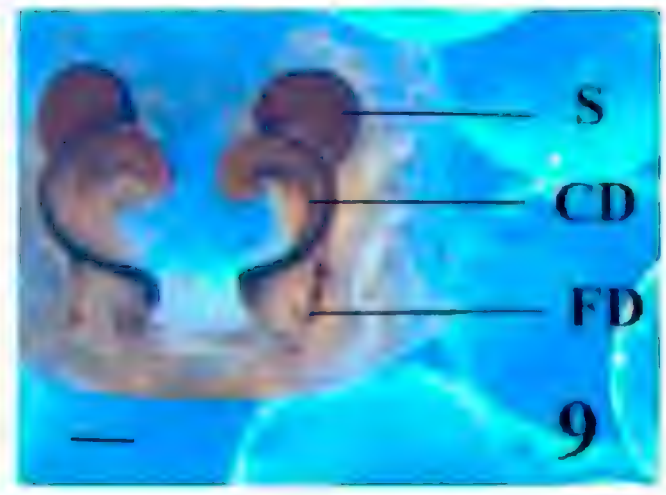
Description. **Female** (Holotype) (Figs. 1-2, 8-9, 13-14). Measurements: TL 7.45, CL 2.02, CW (at the middle) 1.73, AL 4.54, AW (at the middle) 1.56; ocular area length 0.397, width 0.280; ocular diameter: AME 0.075, ALE 0.149, PME 0.115, PLE 0.0.147; ocular inter distance: AME-AME 0.147, AME-ALE 0.076, PME-PME 0.193, PME-PLE 0.277, ALE-PLE 0.248, ALE-ALE 0.109, PLE-PLE 0.748. Clypeus height 0.45. Length of chelicera 0.87. Leg measurements: I 12.17 (3.29, 0.77, 3.44, 3.31, 1.36), II 11.11 (3.34, 0.72, 2.94, 3.09, 1.02), III 8.79 (2.61, 0.63, 2.20, 2.50, 0.85), IV 10.43 (3.19, 0.63, 2.42, 3.23, 0.96). Leg formula 1243. Palp 2.32 (0.85, 0.15, 1.32)[femur, patella+tibia, tarsus]. Spination: Palp: patella do 2, tibia rl 2 pl 2; Legs: femur I-II rl 3 do 3 pl 3, III rl 4 do 2 v 3 pl 4, IV rl 2 do 3 pl 2; patella I rl 1 do 1 pl 1, II rl 2 do 2 rl 2 do 2 pl 2, III rl 1 do 2 v 1 pl 1, IV rl 2 do 2 pl 2; tibia I rl 3 do 3 pl 3, II rl 2 do 2 pl 2, III rl 2 do 2 v 2 pl 2, IV rl 2 do 2 pl 3; metatarsus I-II rl 2 rlv 2 do 2 pl 2, III rl 3 do 3 v 1 pl 3, IV rl 3 do 3 pl 3; tarsus I-IV spineless. Cephalothorax, abdomen and legs yellowish brown in colour, legs with black lines both in dorsal and ventral sides with spines. Cephalothorax posteriorly broad and raised than anterior, narrowly curved anterior tip, carapace with median single and two lateral white bands. Pale red markings on the distal side of carapace. Chelicerae downward with two promarginal teeth, first larger than second, four retromarginal tooth arranged as a distorted quadrangle. Fang is broad at the base and narrowed towards the tip but less pointed. Endite and labium longer than wide. Sternum semi pointed dome shaped with disproportionately arranged setae and yellowish in colour. Abdomen fusiform. Anterior dorsal region is convex and with a distinguishable creamy white marking on the centre. Dark broad bands on lateral and tip of the abdomen. In ventral view, broad dark longitudinal band extends from epigastric furrow to spinnerets. Two tarsal claws. Epigyne less sclerotized with central depression. Copulatory ducts thick and eroteme shaped "?" with anterior end coiled into one turn towards the dorsal side and end with the rounded spermathecae. Fertilization ducts slender and elongated downwards and pointed with a transparent flap at the tip, clearly visible as a separated tube from the copulatory duct (Figs. 8-9, 13-14).











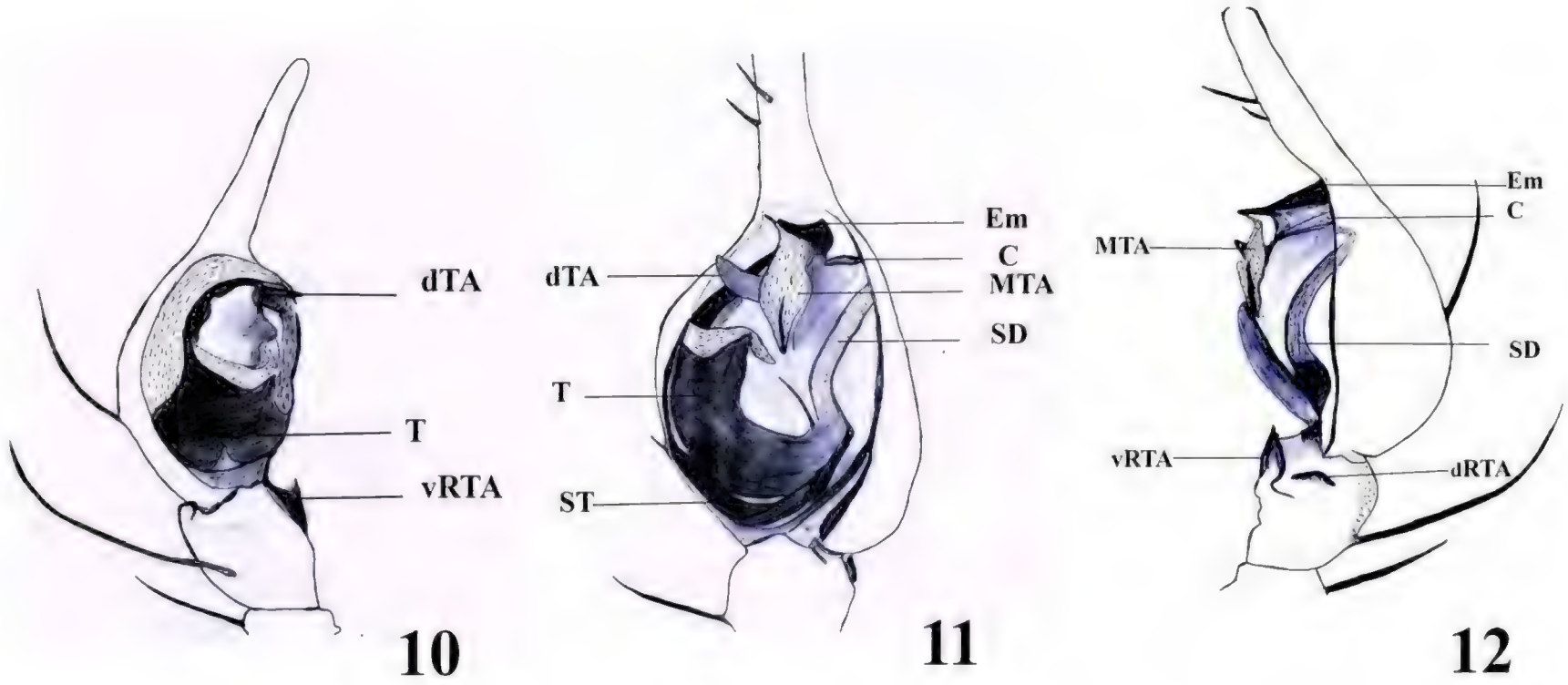
Figs. 5-9. Copulatory organs of *Oxyopes peetham* sp. n. 5-7. Paratype Male, left palp. 5. prolateral view. 6. retrolateral view. 7. ventral view. 8-9. Holotype Female, epigyne. 8. ventral view. 9. dorsal view. (Scale bar: (5-7) 0.5 mm, (8-9) 0.2 mm).

Male. (Paratype) (Figs. 3-7, 10-12). Measurements: TL 5.25, CL 1.58, CW 1.68, AL 2.90, AW 0.82; ocular diameter: AME 0.080, ALE 0.162, PME 0.122, PLE 0.158; ocular distance: AME-AME 0.107, AME-ALE 0.069, PME-PME 0.191, PME-PLE 0.188, ALE-PLE 0.156, ALE-ALE 0.156, PLE-PLE 0.290; Clypeus height 0.38. Length of chelicera 0.85. Leg measurements: I 14.07 (3.58, 0.78, 3.97, 4.02, 1.72), II 11.41 (3.24, 0.61, 3.39, 3.08, 1.09), III 10.12 (2.09, 0.59, 2.90, 3.52, 1.02), IV 10.64 (3.34, 0.57, 1.98, 3.63, 1.12); leg formula 1243. Spination: Legs: femur I-II rl 3 do 3 pl 3, III rl 4 do 2 v 3 pl 4 IV rl 2 do 3 pl 2, patella I rl 1 do 1 pl 1 , II rl 2 do 2 pl 2, III rl 1 do 2 v 1 pl 1, IV rl 2 do 2 pl 2, tibia I rl3 do 3 pl 3, II rl 2 do 2 pl 2, III rl 2 do 2 v 2 pl 2, IV rl 2 do 2 pl 3; metatarsus I-II rl 2 rlv 2 do 2 pl 2, III rl 3 do 3 v 1 pl 3, IV rl 3 do 3 pl 3, tarsus I-IV spineless. Cephalothorax and abdomen pale yellow in colour without any characteristic markings. Abdomen narrowed and in ventral view, two narrow dark longitudinal lines extend from epigastric furrow to spinnerets. Legs pale yellow in colour. Chelicera downwards and has

one promarginal and one retromarginal teeth. The sternum is oil lantern chimney shaped without any setae. Palp: tibia with distinct retrolateral depression between the two adjacent apophyses; ventral retrolateral tibial apophysis large pointed, retrolateral apophysis smaller and ridge shaped; cymbium with elongated anterior apophysis; conductor black not coiled with embolus; embolus slender, originating at 5.30 o'clock position and encompassing prolateral side of genital bulb to 1 o'clock position; median tegular apophysis white pitcher shaped, distal tegular apophysis sclerotized (Figs. 5-7, 10-12).

Distribution. Known only from the type locality.

Natural History. *Oxyopes* species are usually occupied in garden areas and grasslands. Mostly they occur in open vegetation. Mature males and females can be collected during August-September months.



Figs. 10-14. Copulatory organs of *Oxyopes peetham* sp. n. 10-12. Paratype Male, left palp. 10. prolateral view. 11. ventral view. 12. retrolateral view. 13-14. Holotype Female, epigyne. 13. ventral view. 14. dorsal view. (Scale bar: (5-7) 0.5 mm, (8-9) 0.2 mm).

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Araneofauna associated with the horticultural ecosystems of Thrissur District, Kerala, India

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Abstract

Spiders are ecologically very important in agroecosystems as they act as biocontrol agents managing the pest populations. They form an integral part of the food chains operating in croplands. Present study conducted in horticultural ecosystems of Thrissur district, Kerala, India, reported 56 species of spiders belonging to 44 genera and 16 families. The species abundance was in the order Salticidae > Araneidae > Oxyopidae > Lycosidae. Out of the 9 foraging guilds recorded, stalkers emerged as the most prominent one followed by orb weavers and ground runners.

Keywords: Agroecosystems, Foraging guild, Stalkers, Orb weavers, Ground runners.

Introduction

Agriculture forms one of the oldest occupations of man, started for production of food when he began to start settlements in riverbanks. Even now agriculture forms the backbone of the economy of several countries. Pest outbreaks are the most serious issue that he had to face ever since he started to cultivate crops. Even though various strategies are developed for pest control, biological control forms the most sustainable one. It is highly imperative to explore the potential natural enemies, especially the predatory ones for pest management. Spiders, being generalist predators, are the ideal candidate for this (Moulder & Reichle, 1972; Nyffeler & Benz, 1987; Riechert & Bishop, 1990; Young & Edwards, 1990; Kajak *et al*., 1991; Kajak, 1997). Spiders can thrive in natural ecosystems as well as semi natural ecosystems like croplands (Opatovsky *et al*., 2015; Mashavakure

et al., 2019). Their ecological role as a biocontrol agent is a less explored area of research (Srinivasulu *et al*., 2008). It is an irony that such a group of organisms playing a pivotal role in maintaining balance of ecosystems hasn't been given due consideration in terms of conservation. Non judicious use of agrochemicals has adversely affected the faunal diversity of sensitive organisms like spiders in our cropland ecosystems. For sustainable land management strategies that don't hamper spider diversity require an understanding of diversity of spiders in regional scale. Several attempts have so far been made for recording the diversity of spiders in natural ecosystems like forests, grasslands, etc. But the study on their diversity in agricultural ecosystems is still infantile.

Rice lands contribute the lion share of researches on faunal diversity of spiders in agroecosystems of different states of India (Jose *et al*., 2002; Patel *et al*., 2004; 2005; Sebastian *et al*., 2005; Sudhikumar *et al*., 2005; Diraviam *et al*., 2006; Kumar & Shivakumar, 2006; Manisegaran *et al*., 2006; Manu & Bai, 2006; Chatterjee *et al*., 2009; Jayakumar & Sankari, 2010; Sudhikumar & Nafin, 2018). Very few studies have been made in the field of spider diversity in vegetable and fruit croplands of India (Siliwal & Kumar, 2002, 2003a, b; Ntonifor *et al*., 2012; Keswani & Vankhede, 2014). On a global scale, many studies reveal that spiders can be employed as biocontrol agents in croplands of apple (Wyss *et al*., 1995.; Isaia *et al*., 2008) pear and vegetables like cabbage and cauliflower (Pekár *et al*., 2015). Present study investigated the diversity of spiders in the vegetable agroecosystems in Thrissur district, Kerala, India.

Material and Methods

Study Area: The study was carried out in three different vegetable agroecosystems of Thrissur district, Kerala, India (Table 1). Mixed cropping of various vegetables like spinach, long beans, brinjal, chilly with banana was practiced in the crop lands selected for the study.

Sampling and identification: The period of study was from February 2016 to January 2018. Samples were collected once in a month from all three sites. On average four hours were spent in the field preferably between 6:00 am to 1:00 pm. Active searching, handpicking and sweep netting were the common methods adopted for the collecting. All possible microhabitats like under the stones and dry leaves, leaves and twigs of the plants, surface of the soil, etc. were carefully explored. The specimens collected were photographed using Nikon D5200 SLR camera, preserved in 70% alcohol in plastic vials and labelled systematically. The alcohol in the vials was periodically changed to avoid the deterioration of the specimen. Preserved specimens were examined using a stereozoom microscope (Leica-M205C) for their identification. Morphometric characters were mainly used for identification. Sexually mature specimens were identified up to species level using available literature (Barrion & Litsinger, 1995; Caleb & Sankaran, 2022). World Spider Catalog (2022) is also referred to for the final identification. The guild-wise analysis of the spiders identified was done with the help of available literature (Uetz *et al*., 1999; Cardoso *et al*., 2011).

Table 1. Description of the study area.

No.	Site	Geographical co-ordinates	Area (Hectares)
1	Kuzhur village (KZR)	10.2115°N, 76.2914°E	4
2	Bharatha village (BTA)	10.4529°N, 76.2971°E	2
3	Nenmanikkara village (NKA)	10.4376°N, 76.2490°E	3.2

Results

A total of 56 species of spiders belonging to 44 genera and 16 families was recorded from the horticultural ecosystems of Thrissur district (Table 2). Nenmanikkara village showed the highest species richness with 47 species followed by Kuzhur village (43 species) and Bharatha village (39 species). It was also noted that the faunal diversity of spiders varied with the season in all three sites studied. Post-monsoon (POM) season showed the highest diversity followed by Monsoon (MNS) and Pre-monsoon (PRM) (Table 3). Many spiders were present in all three seasons while some were restricted to one or two seasons (Table 4). A few species were reported only in POM (3 species in Kuzhur, 6 in Bharatha and 10 in Nenmanikkara). Salticidae ranked the most abundant family followed by Araneidae and Oxypopidae (Figs. 1-2). Categorization of spiders collected based on foraging patterns showed the existence of nine feeding guilds out of which stalkers formed the most prominent guild followed by Orb weaver and Ground runners (Fig. 3, Table 5).

Table 2. Spider diversity across the seasons in horticultural ecosystems of Thrissur district, Kerala.

No.	Species	KZR			BTA			NKA		
		PRM	MNS	POM	PRM	MNS	POM	PRM	MNS	POM
	Family Araneidae Clerck, 1757									
1	*Anepsion maritatum* (O. Pickard-Cambridge, 1877)	+	-	+	+	+	+	+	+	+
2	*Argiope aemula* (Walckenaer, 1841)	-	-	-	-	+	-	-	-	-
3	*Argiope anasuja* Thorell, 1887	+	-	+	+	-	+	-	-	+
4	*Argiope pulchella* Thorell, 1881	+	-	+	+	-	-	-	+	+
5	*Cyrtarachne* sp.	-	-	+	+	-	+	-	-	-
6	*Cyrtophora cicatrosa* (Stoliczka, 1869)	-	-	+	+	-	+	+	+	+
7	*Cyrtophora citricola* (Forsskål, 1775)	-	+	+	-	+	+	-	+	+
8	*Gasteracantha geminata* (Fabricius, 1798)	-	+	+	-	-	-	-	+	+
9	*Neoscona inusta* (L. Koch, 1871)	+	-	-	+	-	+	-	-	-
10	*Neoscona mukerjei* Tikader, 1980	+	+	+	-	-	+	+	+	+
	Family Cheiracanthiidae Wagner, 1887									
11	*Cheiracanthium danieli* Tikader, 1975	+	-	+	-	-	-	-	-	+
	Family Gnaphosidae Banks, 1892									
12	*Drassodes* sp.	+	-	+	-	-	-	-	-	-
	Family Hahniidae Bertkau, 1878									
13	*Hahnia mridulae* Tikader, 1970	-	-	-	-	-	-	-	-	+
	Family Hersiliidae Thorell, 1869									
14	*Hersilia savignyi* Lucas, 1836	-	-	-	-	-	-	-	-	
	Family Lycosidae Sundevall, 1833									
15	*Hippasa agelenoides* (Simon, 1884)	+	+	+	+	+	+	+	+	+
16	*Lycosa mackenziei* Gravely, 1924	-	-	+	-	-	+	-	+	+

Family Oxyopidae Thorell, 1869										
17	*Oxyopes birmanicus* Thorell, 1887	+	+	+	+	+	+	+	+	+
18	*Oxyopes javanus* Thorell, 1887	+	+	+	-	+	+	+	+	+
19	*Oxyopes lineatipes* (C.L. Koch, 1847)	-	-	+	-	-	-	-	-	-
20	*Oxyopes pankaji* Gajbe & Gajbe, 2000	-	-	-	-	-	-	-	-	+
21	*Oxyopes shweta* Tikader, 1970	-	+	+	-	+	+	+	+	+
22	*Oxyopes sunandae* Tikader, 1970	-	+	+	-	+	+	-	-	+
23	*Peucetia viridana* (Stoliczka, 1869)	-	-	-	-	-	+	-	+	+
Family Philodromidae Thorell, 1870										
24	*Philodromus* sp.	-	-	+	-	-	-	-	-	-
Family Pholcidae C.L. Koch, 1850										
25	*Pholcus phalangioides* (Fuesslin, 1775)	-	-	-	-	-	-	-	+	+
Family Pisauridae Simon, 1890										
26	*Dendrolycosa gitae* (Tikader, 1970)	-	+	+	-	-	-	-	-	-
Family Salticidae Blackwall, 1841										
27	*Asemonea tenuipes* (O. Pickard-Cambridge, 1869)	+	+	+	+	+	-	-	+	+
28	*Brettus cingulatus* Thorell, 1895	-	+	+	+	+	+	+	+	+
29	*Carrhotus viduus* (C.L. Koch, 1846)	-	+	+	-	-	+	+	+	+
30	*Epeus tener* (Simon, 1877)	+	-	+	-	-	-	-	+	+
31	*Evarcha falcata* (Clerck, 1757)	-	-	-	+	+	+	-	-	-
32	*Evarcha* sp.	-	-	-	+	+	-	-	-	-
33	*Hasarius adansoni* (Audouin, 1825)	+	+	+	-	+	+	+	+	+
34	*Hyllus semicupreus* (Simon, 1885)	-	+	+	-	+	+	+	+	+
35	*Indopadilla insularis* (Malamel, Sankaran & Sebastian, 2015)	+	+	+	+	+	+	+	+	+
36	*Menemerus bivittatus* (Dufour, 1831)	-	-	+	-	-	+	-	-	+
37	*Myrmaplata plataleoides* (O. Pickard-Cambridge, 1869)	+	+	+	+	-	+	+	+	+
38	*Myrmarachne melanocephala* MacLeay, 1839	-	-	+	-	-	+	-	+	+
39	*Phidippus yashodharae* Tikader, 1977	-	+	+	-	+	+	-	+	+
40	*Phintella vittata* (C.L. Koch, 1846)	+	+	+	+	+	+	+	+	+
41	*Plexippus paykulli* (Audouin, 1826)	+	+	+	+	+	+	+	+	+
42	*Plexippus petersi* (Karsch, 1878)	+	+	+	+	+	+	+	+	+
43	*Rhene flavigera* (C.L. Koch, 1846)	-	-	+	-	-	+	-	+	+
44	*Siler semiglaucus* (Simon, 1901)	-	+	+	+	+	+	+	+	+
45	*Stenaelurillus* sp.	-	-	-	-	-	+	-	-	-
46	*Telamonia dimidiata* (Simon, 1899)	-	+	+	-	+	+	+	+	+
Family Scytodidae Blackwall, 1864										
47	*Scytodes fusca* Walckenaer, 1837	-	-	-	-	+	-	-	-	-
Family Sparassidae Bertkau, 1872										
48	*Heteropoda venatoria* (Linnaeus, 1767)	+	+	+	-	+	+	+	+	+
Family Tetragnathidae Menge, 1866										
49	*Leucauge dorsotuberculata* Tikader,	-	-	-	+	+	+	-	-	-

	1982									
50	*Tetragnatha cochinensis* Gravely, 1921	-	-	+	+	-	+	-	-	+
51	*Tetragnatha mandibulata* Walckenaer, 1841	-	-	-	+	-	-	+	+	+
52	*Tylorida ventralis* (Thorell, 1877)	+	+	+	+	+	+	-	-	+
	Family Theridiidae Sundevall, 1833									
53	*Argyrodes kumadai* Chida & Tanikawa, 1999	-	-	-	-	-	-	-	+	+
54	*Meotipa argyrodiformis* (Yaginuma, 1952)	-	-	-	-	-	-	-	+	+
	Family Thomisidae Sundevall, 1833									
55	*Strigoplus netravati* Tikader, 1963	-	-	-	-	-	-	+	-	+
56	*Thomisus projectus* Tikader, 1960	+	-	-	-	+	-	-	-	+

Table 3. Seasonal variation in number of species.

Season	Site 1 KZR	Site 2 BTA	Site 3 NKA
Pre-monsoon (PRM) (February - May)	21	22	21
Monsoon (MNS) (June - September)	24	26	33
Post-monsoon (POM) (October - January)	39	35	44

Table 4. Seasonal specificity of spiders.

Species present in:	KZR	BTA	NKA
All three seasons	10	8	17
In any two seasons	18	19	18
In any one season only	14	12	11

Table 5. Guild wise distributions of spiders.

No.	Feeding Guild	%
1	Ambusher	7
2	Foliage runner	2
3	Ground runner	5
4	Orb weaver	27
5	Other hunters	4
6	Sensing web	2
7	Sheet web builder	2
8	Space web builder	4
9	Stalker	48

Discussion

Agroecosystems generally accommodate high diversity of arthropods including spiders. Rich foliage, dry leaves and decaying mulch in the ground, etc. serve as different microhabitats suitable for the spiders to thrive successfully. Increased humidity and availability of different insect pests also act as one of the key factors that support spider fauna in cropland ecosystems. Keswani & Vankhede (2014) in their studies on banana agroecosystems of Purna river (a tributary of Tapti river) basin of Maharashtra, reported Araneidae as the most abundant family followed by Salticidae and Lycosidae. Oxyopidae

was less abundant there. On the contrary to that, in the present study, Salticidae ranks the most abundant family followed by Araneidae and Oxyopidae. Mixed cropping of vegetables along with banana in the study sites might have resulted in more diverse microhabitats, which may be a possible reason for this. Several studies reported Salticidae as the most abundant family in agroecosystems (Bhat *et al.*, 2013; Virale, 2019).

The present study in horticultural ecosystems in Thrissur district mainly used sweep netting and visual searching methods only, for the collection of spiders. Other methods like beating, pitfall traps, etc. were not employed as they were not suitable for cropland ecosystems from an economic point of view. Adopting other methods may ensure still higher diversity. Hence a further elaborate study is highly recommended.

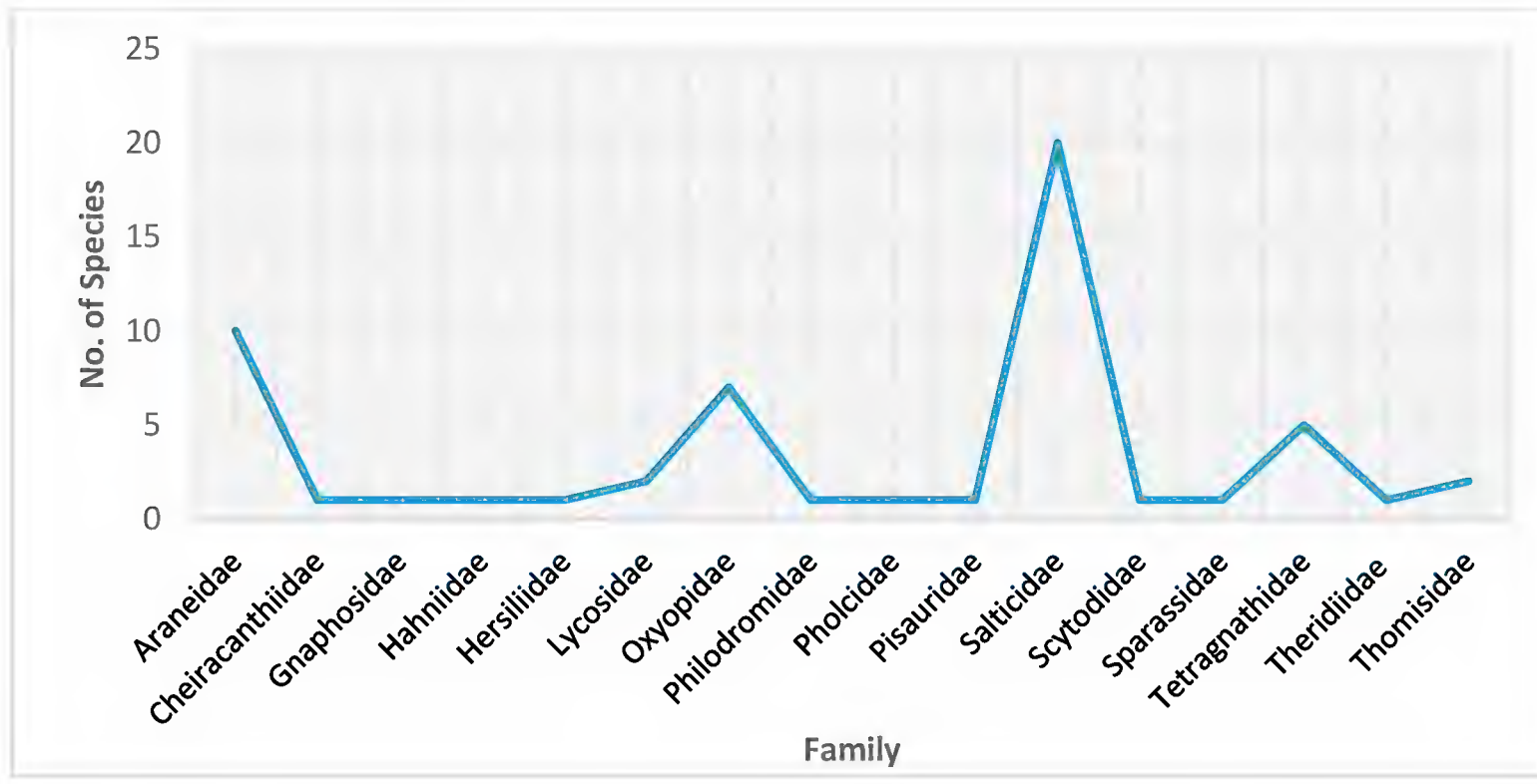

Fig. 1. Family wise abundance of species collected from horticultural ecosystems.

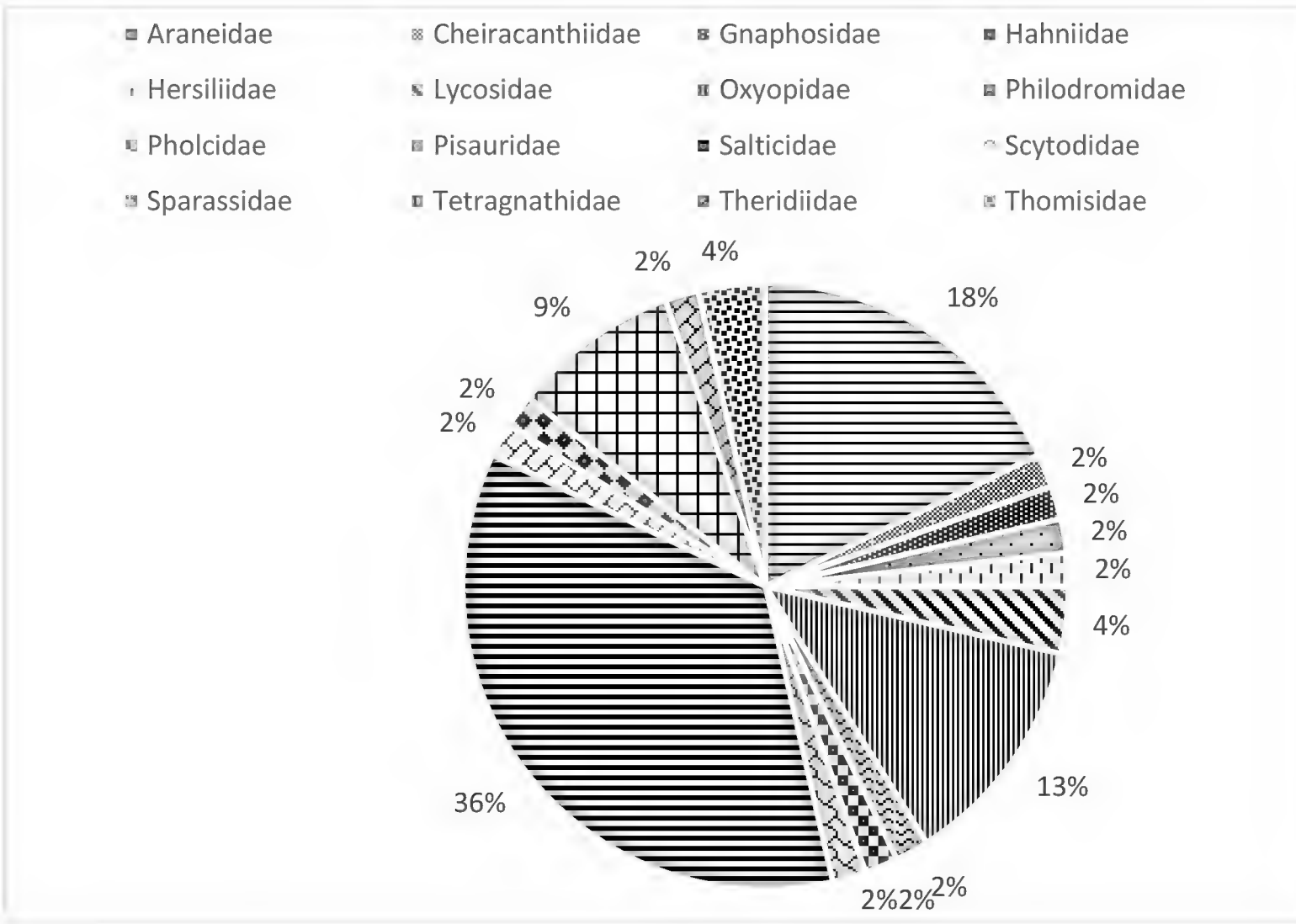

Fig. 2. Composition (%) of spider families in Horticultural ecosystem of Thrissur district.

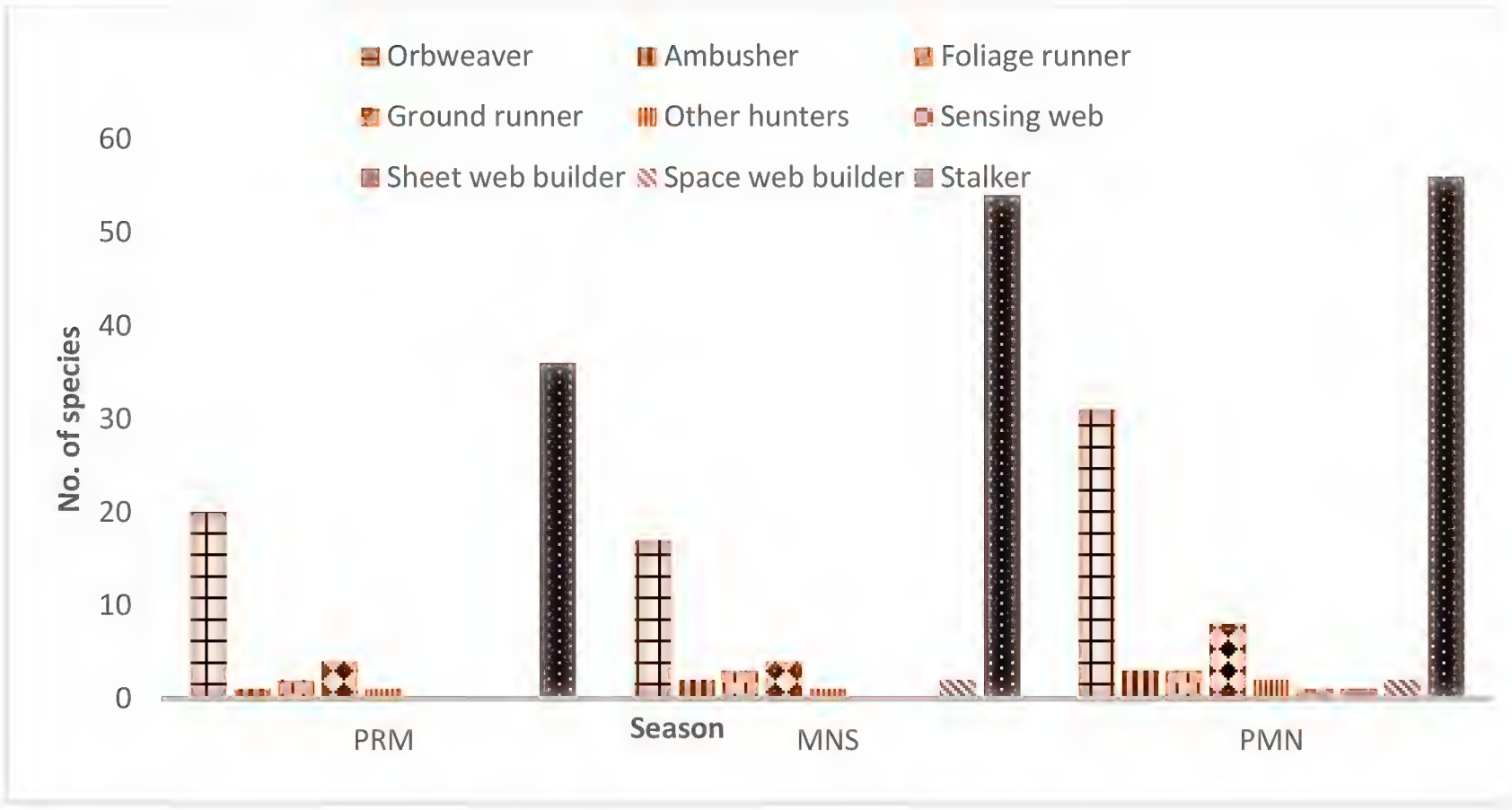

Fig. 3. Seasonal variation in guild structure of spiders in the horticultural ecosystem.

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Diversity of spiders in riparian habitats of Kalpathipuzha, Palakkad, Kerala, India

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Abstract

Spiders are highly agile, polyphagous arthropods distributed in highly diverse habitats. Occurrence and relative abundance of spiders roughly corresponds to the 'well-being' of the habitats. Riparian habitats serve as transition zones between a truly terrestrial and aquatic ecosystems. They serve to link the food chains operating in both the flanking habitats. Given work focused on assessing the diversity in distribution of spiders along the banks of Kalpathipuzha; one of the major tributaries of Bharathapuzha, the second longest river in Kerala. The study recorded 66 species of spiders belonging to 53 genera distributed in 21 families. The number of families reported in this study contributes to 35% of those so far reported from India. Salticidae was the dominant family, comprising 17 species. Comparison of the species diversity from three study sites across three seasons revealed higher values in Site 1, Malampuzha, during post monsoon season. Analysis of guild structure indicated stalkers as the most dominant.

Keywords: Spider, diversity, riparian habitat, transition zone, Kalpathipuzha, Bharathapuzha.

Introduction

Spiders are very dynamic and highly diverse group of invertebrates equipped with remarkable ability of camouflage and mimicry that makes them capable of adapting to multitude of habitats. They play pivotal role in ecosystems serving as polyphagous predators of many obnoxious pests of economically important crops. Large scale and

unscrupulous application of many synthetic pesticides have left far reaching consequences on spider community. The diversity, wide distribution and obligate predatory nature of spiders make them one of the most appropriate model organisms for community ecology studies (Patrick *et al*., 1999). Simultaneous deficiency of experts and systematic keys to deal with identification of spiders poses a major hurdle in this scenario. Recently many hitherto unknown species of spiders were reported from Western Ghats and many parts of Kerala (Caleb *et al*., 2019; Sudhin *et al*., 2021; Vishnudas & Sudhikumar, 2021). Integration of modern amenities offered by biotechnology and bioinformatics have enriched diversity studies, especially in the realms of identification and comparison.

River banks with moist and fertile soil support a large number of fauna and flora. Bharathapuzha is one among the most prominent and of course highly 'threatened' rivers of Kerala. It harbours a vast variety of endemic species of animals. This river, with its rich network of tributaries forms the lifeline of central and northern districts of Kerala. From a biodiversity point of view, riparian habitats could be considered as ecotones, where one could expect a high degree of overlap of species present on bordering ecosystems. Riparian habitats harbour characteristic vegetation. A direct link between vegetation structure and spider diversity had been investigated (Hore & Uniyal, 2008; Gomez *et al*., 2016). In contrast to the common ecosystems, spiders also occupy higher trophic levels as top predators and thereby significantly contribute to the riparian food chains (Henschel *et al*., 2001). Riparian spiders in general prey upon both aquatic and terrestrial insects (Williams, 1979; Williams *et al*., 1995).

Material and Methods

Study Area: Three sites in Palakkad district of Kerala, India associated with Kalpathipuzha, one of the major tributaries of Bharathapuzha were selected for study; Malampuzha (MPZ) (10.8281°N, 76.7368°E), Parali (PRL) (10.8028°N, 76.5584°E), and Walayar (WLY) (10.8428°N, 76.8388°E).

Methods: The study was conducted from February 2017 to January 2018. The whole period of study was divided into three seasons comprising four months each; pre monsoon (February to May), monsoon (June to September) and post monsoon (October to January). Collecting from all the three sites were done in all three seasons. Both right and left banks of the river were considered in each collecting. A line transect (25 metres long and 2.5 metres wide) method was predominantly adopted. Methods of collecting included active searching, inverted umbrella method, and litter sampling. Collected specimens were photographed and preserved in 70% isopropyl alcohol in vividly labelled vials. Identification of adult specimens up to species level was carried out using available literature (Barrion & Litsinger, 1995; Sebastian & Peter, 2009). World Spider Catalog (2022) is considered as the basis for scientific names. As the strategies adopted by spiders for prey capturing are diverse, they were classified under various feeding guilds (Cardoso *et al*., 2011; Uetz *et al*., 1999). The names of spiders identified were tabulated and data from the three sites across three seasons were compiled to a single check list. Number of species of spiders identified in each family were tabulated along with the corresponding feeding guilds.

Results

The study recorded 66 species of spiders, belonging to 53 genera and 21 families (Table 1). Salticidae was the dominant family with 17 species (Fig. 1). Many of the

families recorded were represented by single species. Maximum number of species was obtained during post monsoon (POM), followed by pre monsoon (PRM) and monsoon (MNS). Representatives of 35% of the families recorded from India were obtained during the study (Caleb & Sankaran, 2022). Guild structure analysis revealed stalkers as the most abundant guild, comprising up to 32% of the species obtained (Table 2, Fig. 2).

Table 1. List of spiders collected from the riparian habitats of Kalpathipuzha.

No.	Family / Species	Site 1 (PRL)			Site 2 (MPZ)			Site 3 (WLY)		
		PRM	MNS	POM	PRM	MNS	POM	PRM	MNS	POM
I	**Araneidae**									
1	*Anepsion maritatum* (O. Pickard-Cambridge, 1877)	+	-	-	+	+	+	+	-	+
2	*Bijoaraneus mitificus* (Simon, 1886)	+	-	+	+	-	+	+	+	-
3	*Argiope aemula* (Walckenaer, 1841)	+	+	+	+	-	-	+	-	+
4	*Argiope pulchella* Thorell,1881	-	+	+	+	+	+	+	+	-
5	*Cyclosa bifida* (Doleschall, 1859)	+	-	+	-	-	+	+	-	+
6	*Cyclosa hexatuberculata* Tikader, 1982	+	+	+	+	-	+	+	+	-
7	*Eriovixia laglaizei* (Simon, 1877)	+	-	-	-	+	-	+	+	-
8	*Gasteracantha geminata* (Fabricius, 1798)	-	+	+	+	-	+	+	-	+
9	*Neoscona mukerjei* Tikader, 1980	+	+	+	+	+	+	+	+	+
10	*Neoscona nautica* (L. Koch, 1875)	-	-	+	+	-	-	+	-	+
II	**Cheiracanthiidae**									
11	*Cheiracanthium danieli* Tikader, 1975	+	+	+	+	-	+	-	+	+
12	*Cheiracanthium melanostomum* (Thorell, 1895)	+	-	+	-	-	-	-	-	+
III	**Clubionidae**									
13	*Clubiona* sp.	-	-	+	-	-	-	-	-	+
IV	**Corinnidae**									
14	*Castianeira zetes* Simon, 1897	+	-	-	-	-	+	-	+	-
V	**Ctenidae**									
15	*Ctenus* sp.	+	-	-	-	-	+	-	-	-
VI	**Eresidae**									
16	*Stegodyphus sarasinorum* Karsch, 1892	-	+	+	+	-	-	-	-	+
VII	**Gnaphosidae**									
17	*Drassodes* sp.	-	-	+	-	-	+	-	-	-
VIII	**Hersiliidae**									
18	*Hersilia savignyi* Lucas, 1836	+	+	+	+	-	-	-	+	+
IX	**Linyphiidae**									
19	*Linyphia* sp.	+	-	-	-	-	-	+	-	+
X	**Lycosidae**									
20	*Hippasa agelenoides* (Simon,1884)	+	+	+	+	+	+	+	+	+
21	*Lycosa mackenziei* Gravely, 1924	-	+	+	-	-	+	-	-	+
22	*Lycosa* sp.	+	-	+	+	-	-	-	+	-
23	*Pardosa pseudoannulata* (Bösenberg & Strand, 1906)	+	+	+	-	+	+	-	+	-

XI	**Oxyopidae**									
24	*Oxyopes birmanicus* Thorell, 1887	-	+	+	+	+	+	+	-	+
25	*Oxyopes javanus* Thorell, 1887	+	-	+	+	-	-	-	+	+
26	*Oxyopes sunandae* Tikader, 1970	+	+	-	-	-	+	-	-	-
27	*Peucetia viridana* (Stoliczka, 1869)	-	-	+	-	+	-	-	-	-
XII	**Philodromidae**									
28	*Philodromus* sp.	-	+	+	+	-	-	-	-	+
29	*Tibellus elongatus* Tikader, 1960	+	-	+	-	-	-	-	+	-
XIII	**Pholcidae**									
30	*Pholcus* sp.	-	-	+	-	-	-	-	-	-
XIV	**Pisauridae**									
31	*Dendrolycosa gitae* (Tikader, 1970)	-	-	+	-	-	+	-	-	-
XV	**Salticidae**									
32	*Asemonea tenuipes* (O. Pickard-Cambridge, 1869)	+	-	-	+	-	+	-	-	+
33	*Carrhotus viduus* (C.L. Koch, 1846)	+	+	+	-	+	-	+	+	-
34	*Chrysilla volupe* (Karsch, 1879)	-	+	-	-	+	+	-	-	+
35	*Epeus indicus* Prószyński, 1992	+	+	-	+	-	-	-	-	+
36	*Hasarius adansoni* (Audouin, 1825)	+	+	+	-	+	+	+	-	+
37	*Hyllus semicupreus* (Simon, 1885)	+	+	+	+	+	+	+	+	+
38	*Indopadilla insularis* (Malamel, Sankaran & Sebastian, 2015)	-	+	+	-	-	+	+	-	-
39	*Myrmaplata plataleoides* (O. Pickard-Cambridge, 1869)	+	+	+	+	+	-	+	+	-
40	*Myrmarachne melanocephala* MacLeay, 1839	-	-	+	-	-	+	-	-	-
41	*Phidippus yashodharae* Tikader, 1977	+	-	-	-	-	+	-	-	+
42	*Phintella vittata* (C.L. Koch, 1846)	-	+	+	-	+	-	-	-	+
43	*Plexippus paykulli* (Audouin, 1825)	-	+	+	+	+	-	+	+	+
44	*Plexippus petersi* (Karsch, 1878)	+	-	-	+	-	+	-	+	-
45	*Rhene* sp.	+	-	+	+	-	+	-	-	-
46	*Siler semiglaucus* (Simon, 1901)	+	-	-	-	+	+	-	-	+
47	*Stenaelurillus sp.*	+	-	-	+	-	+	-	-	-
48	*Telamonia dimidiata* (Simon, 1899)	-	+	+	+	+	-	+	+	+
XVI	**Scytodidae**									
49	*Scytodes pallida* Doleschall, 1859	-	+	+	-	+	-	+	+	-
50	*Scytodes thoracica* (Latreille, 1802)	+	-	-	-	-	+	-	-	+
XVII	**Sparassidae**									
51	*Heteropoda venatoria* (Linnaeus, 1767)	-	+	+	+	+	+	+	+	+
52	*Olios milleti* (Pocock, 1901)	+	-	-	-	+	-	-	-	-
XVIII	**Tetragnathidae**									
53	*Leucauge decorata (*Blackwall, 1864)	-	+	+	+	-	+	+	-	-
54	*Leucauge dorsotuberculata* (Tikader, 1982)	+	+	+	+	+	-	+	-	+
55	*Tetragnatha mandibulata* Walckenaer, 1841	-	+	+	+	+	-	+	+	-
56	*Tetragnatha viridorufa* Gravely, 1921	+	+	+	-	-	+	-	+	+
57	*Tylorida* sp.	+	-	-	+	+	-	+	+	-
XIX	**Theridiidae**									
58	*Argyrodes flavescens* O. Pickard-Cambridge, 1880	-	+	+	+	+	+	-	-	-

59	*Chrysso* sp.	+	-	-	-	+	+	-	-	-
60	*Theridion manjithar* Tikader, 1970	+	+	+	+	+	-	+	+	+
XX	**Thomisidae**									
61	*Indoxysticus minutus* (Tikader, 1960)	-	-	+	-	+	-	-	+	-
62	*Oxytate sp.*	-	+	+	-	-	+	-	-	+
63	*Thomisus lobosus* Tikader, 1965	-	+	+	+	+	+	+	+	+
64	*Thomisus projectus* Tikader, 1960	+	+	+	-	+	+	+	+	+
65	*Thomisus pugilis* Stoliczka, 1869	+	-	-	+	+	-	+	-	-
XXI	**Uloboridae**									
66	*Uloborus* sp.	+	-	-	-	-	+	-	-	-

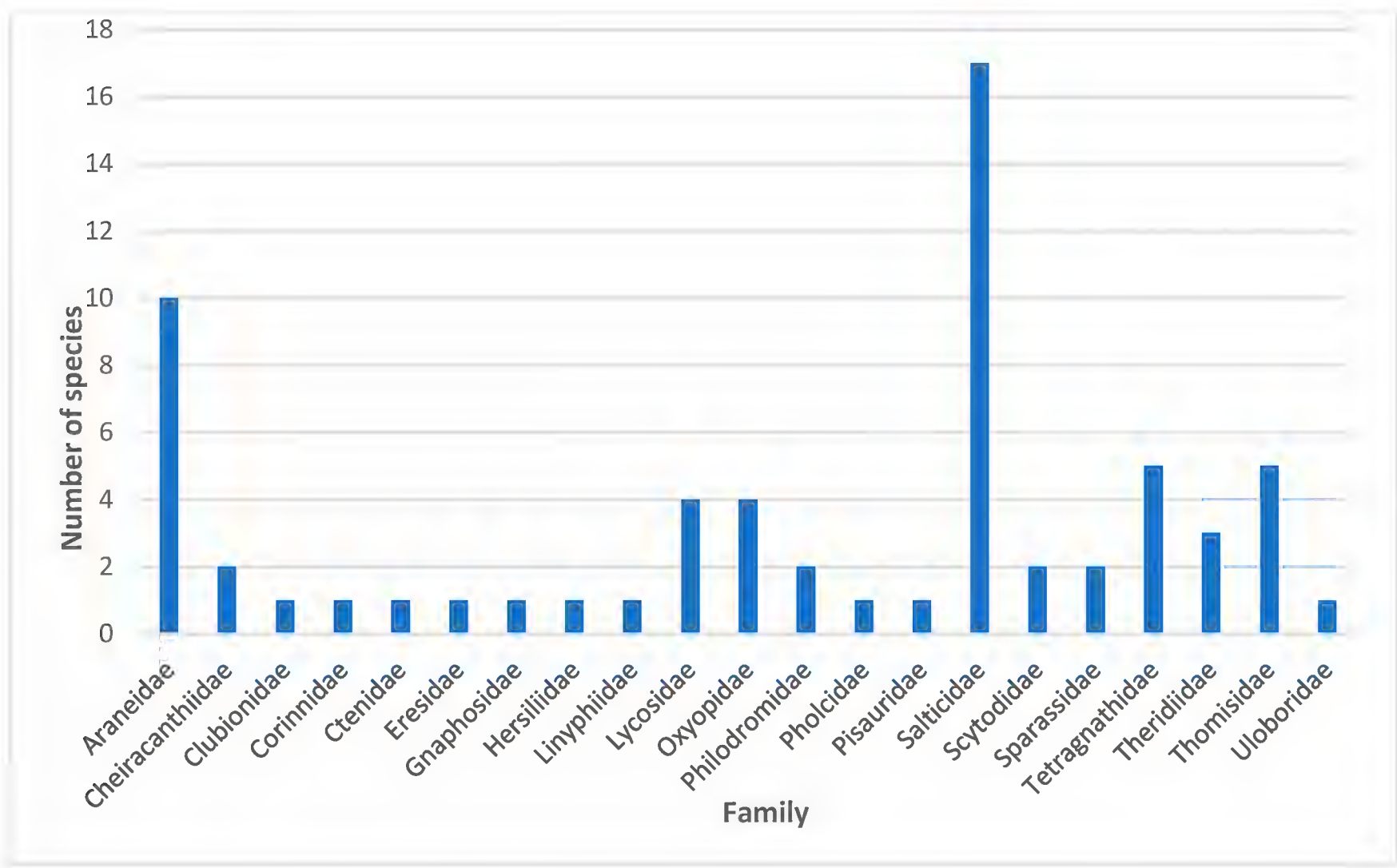

Fig. 1. Family wise abundance of collected spiders.

Discussion

From the data available, we could notice many of the spiders were represented only once across all the three sites and all three seasons under consideration. *Hippasa agelenoides* (Lycosidae) and *Hyllus semicupreus* (Salticidae) were invariably present among all sites and all seasons, indicating higher range of adaptability. Out of the 21 families, 10 had only single species representatives. This could be considered to be clear evidence of high degree of dominance exerted by some families, taking advantage of their feeding guilds over others. The river selected for study is highly deteriorating one due to sand mining and high inputs of detergents, all due to human interference. Conservation of such fragile ecosystems is a matter of immediate concern.

Table 2. Guild wise distribution of spiders.

No.	Family	Guild	Number of species
1 2 3	Araneidae Tetragnathidae Uloboridae	Orb weavers	16
4 5	Clubionidae Sparassidae	Foliage runner	3
6 7	Lycosidae Gnaphosidae	Ground runners	5
8 9	Oxyopidae Salticidae	Stalkers	21
10 11 12	Philodromidae Pisauridae Thomisidae	Ambushers	8
13	Linyphiidae	Wandering sheet weavers	1
14 15	Theridiidae Pholcidae	Space web builders	4
16 17 18	Hersiliidae Ctenidae Corinnidae	Sensing web	3
19	Eresidae	Sheet web	1
20 21	Scytodidae Cheiracanthiidae	Other hunters	4
	Total		66

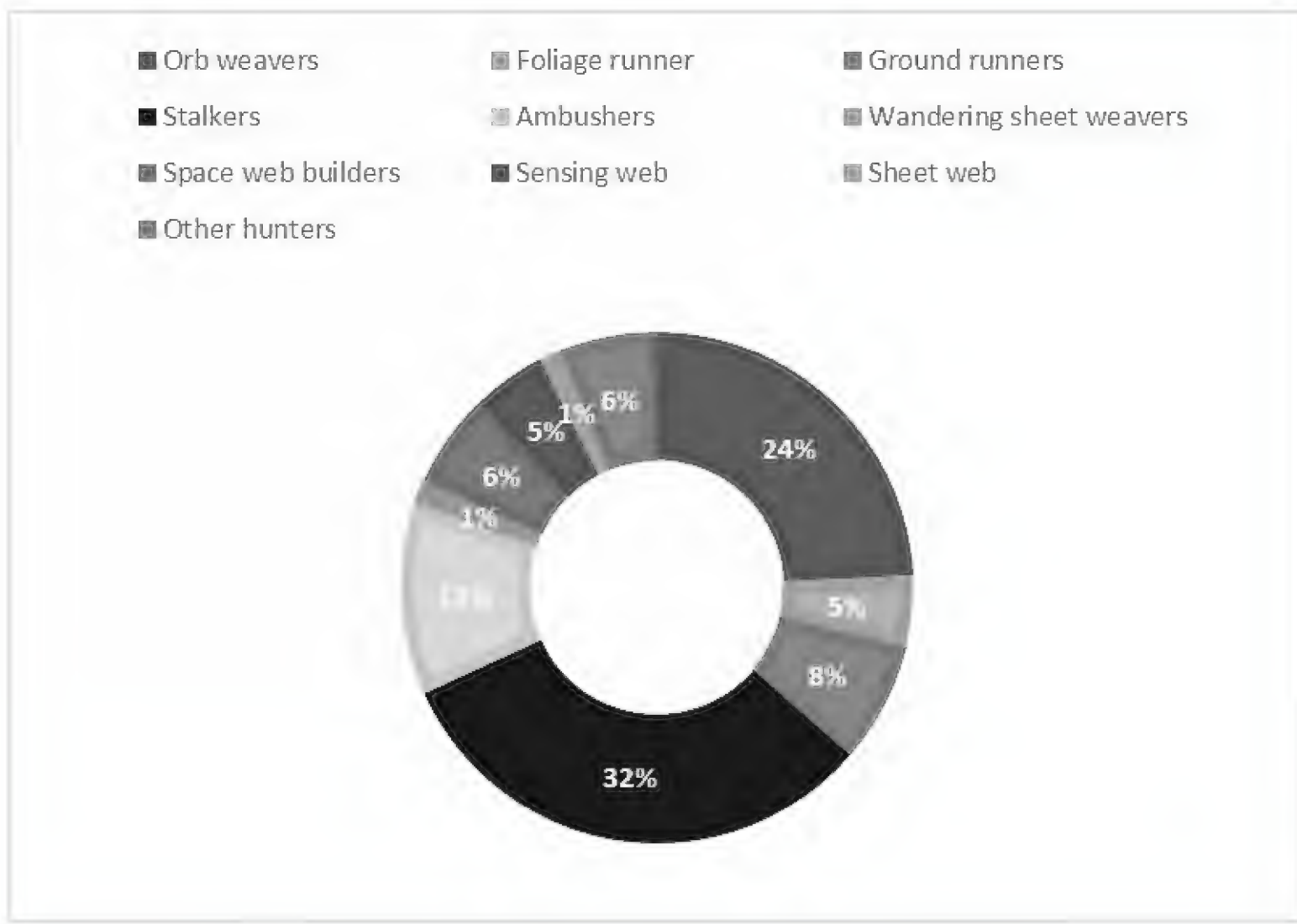

Fig. 2. Guild composition of collected spiders.

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The first record of *Stemonyphantes agnatus* Tanasevitch, 1990 (Araneae: Linyphiidae) in Turkey

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Abstract

The linyphiid spider species *Stemonyphantes agnatus* Tanasevitch, 1990 is recorded for the first time from Turkey. In this short paper, the characteristic features and photographs of this species from Turkey are presented. This increases the total number of species of family Linyphiidae recorded in Turkey to 117 species.

Keywords: Araneae, Linyphiidae, *Stemonyphantes agnatus*, new record, Turkey.

Introduction

Members of family Linyphiidae, which are difficult to identify with their small body structures and known for their scattered webs, constitute the second largest family among spiders. Family Linyphiidae Blackwall, 1859 has 1366 species in 222 genera known from Europe (Nentwig *et al.*, 2022) and 4717 species in 622 genera described worldwide (World Spider Catalog, 2022). A total of 1129 spider species in 54 families are known in Turkey including 116 species in 68 genera of family Linyphiidae (Danışman *et al.*, 2021). This paper deals with the characteristic features and distribution of *Stemonyphantes agnatus* Tanasevitch, 1990 adding it as a new linyphiid species to the araneo-fauna of Turkey.

Material and Methods

The present study is based on the material collected in 2016 from Rize in Turkey. The specimen was collected from forest by means of sifter and hand aspirator during the

daytime. The specimen was preserved in 70% ethanol and deposited in the collection of the Zoological Museum of Kastamonu University (KUZM). The identification was made with a Leica S8APO microscope and pictures were taken by means of a Leica DC 160 camera. SEM micro photographs were taken by Jeol JSM 5600 Scanning Electron Microscope. Identification of the species depended on Tanasevitch (1990), Zamani *et al.* (2020), and Nentwig *et al.* (2022). Measurements of legs are as follows: total length (femur+patella+tibia+metatarsus+tarsus). All measurements are given in millimetres.

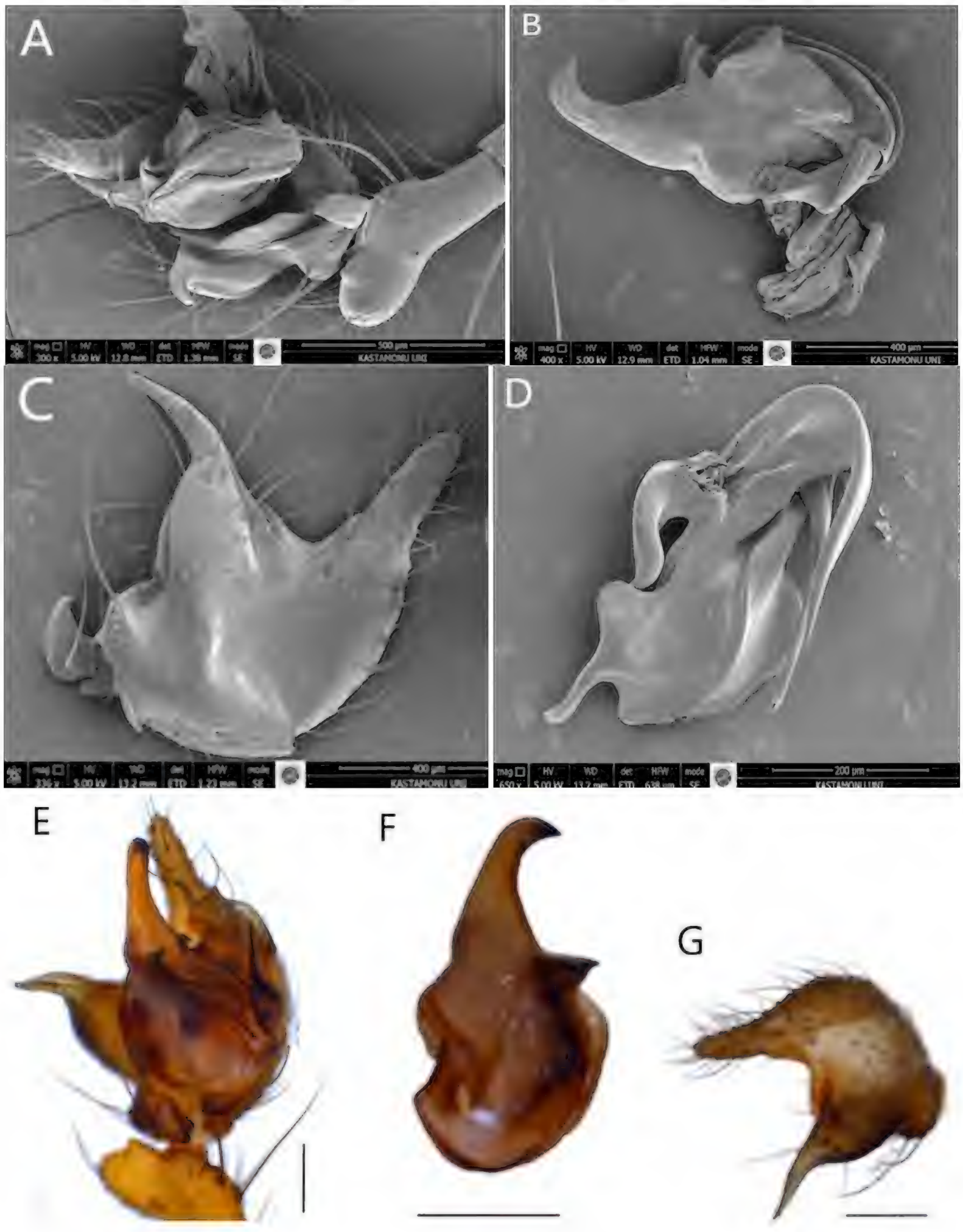

Fig. 1. *Stemonyphantes agnatus* Tanasevitch, 1990 ♂, left palp. A, E. ventral view. B, F. Tegular apophysis. C, G. Cymbium. D. Embolic division and embolus. A-D. scanning electron micrographs. E-G. light microscope photos. Scale bars: 0.5 mm.

Results

Stemonyphantes agnatus Tanasevitch, 1990

Material examined: 1♂, Turkey, Rize Province, Hemşin Yaltkaya District, (41°04'12.2"N, 40°53'26.5"E, 520 m), 12.05.2016, from short vegetation and small bushes in the forest, leg. Z. Sancak.

Description: Male Body length 5.5. Prosoma length 2.8, abdomen length 2.7. Carapace length 2.0, width 1.8. The body is generally yellow-brown in appearance. Prosoma yellow brown. Ocular area dark. Abdomen black and white patterned with dark horizontal stripes. Legs light brown, terminal segments brown, darkened; with a single dorsal spine on femur. Leg I 6.09 (2.05+0.59+1.84+1.15+0.46), leg II 5.59 (2.02+0.50+1.55+1.10+0.42), leg III 3.51 (1.50+0.30+0.56+0.75+0.40), leg IV 5.46 (2.00+0.50+1.50+1.01+0.45). Embolus division u-shaped with blunt end. Cymbium pointed, two-pronged. Tegular apophysis terminal dark (Figs. A-G).

Global distribution: Caucasus (southern Russia, Georgia, Azerbaijan), Ukraine, and Iran (World Spider Catalog, 2021).

Discussion

Three endemic species of genus *Stemonyphantes* Menge, 1866 are known in Turkey, *i.e. S. abantensis* Wunderlich, 1978, *S. montanus* Wunderlich, 1978, and *S. serratus* Tanasevitch, 2011. They are quite similar to each other in terms of their somatic characteristics. Now, *S. agnatus* Tanasevitch, 1990 is added to the araneo-fauna of Turkey. Due to its geographical location, the work on spiders in our country, which is rich in fauna and flora diversity in its own right, is still gaining momentum with its newness. The most common group in nature is family Linyphiidae with its very large number of species. Most species are tiny and some of them are among the smallest spiders. Turkish spiders have been poorly studied, despite the increase in their studies during recent years. There are still many regions of the country that remain insufficiently investigated.

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New locality record of *Pellenes diagonalis* (Simon, 1868) (Araneae: Salticidae) in Turkey

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Abstract

Pellenes diagonalis (Simon, 1868) is known from Turkey except for the Central Anatolian Region. In this study, we could find this species from a new locality to its distribution in Anatolia. Its general habitus and male genitalia are illustrated.

Keywords: Spiders, *Pellenes diagonalis*, new locality, Anatolia. Turkey.

Introduction

Salticidae Blackwall, 1841 is the largest family in Order Araneae and is currently represented by 6394 species belonging to 662 genera worldwide (World Spider Catalog, 2022). There are 134 species in 42 salticid genera listed for Turkey (Topçu *et al.*, 2005; Demir & Seyyar, 2017; Danışman *et al.*, 2021).

Eight species of genus *Pellenes* Simon, 1876 are known from Turkey: *P. brevis* (Simon, 1868), *P. diagonalis* (Simon, 1868), *P. epularis* (O. Pickard-Cambridge, 1872), *P. flavipalpis* (Lucas, 1853), *P. geniculatus* (Simon, 1868), *P. moreanus* Metzner, 1999, *P. nigrociliatus* (Simon, 1875), and *P. seriatus* (Thorell, 1875). Among them, the species *P. diagonalis* is known from four different regions of Turkey: Southeastern Anatolia Region (SAR) and Mediaterranean Region (MR) (Çoşar, 2020), Aegean Region (AR) and East Anatolia Region (EAR) (Logunov, 2015).

We could find a new locality, Central Anatolia Region (CAR), for this species from Turkey. The aim of this paper is to present a new locality record of the salticid spider *Pellenes diagonalis* (Simon, 1868) in Turkey. The new finding of this species widens its distribution in Turkey (Fig. 1).

Material and Methods

In this study, two male specimens were collected from Hasan Mountain in Central Anatolia. Examined specimens were preserved in 70% ethanol and deposited in the NÖHUAM (Niğde Ömer Halisdemir University Arachnological Museum). For identification, Metzner (1999) and Prószyński (2017) were consulted. The identification was made by means of a SZX61 Olympus stereomicroscope.

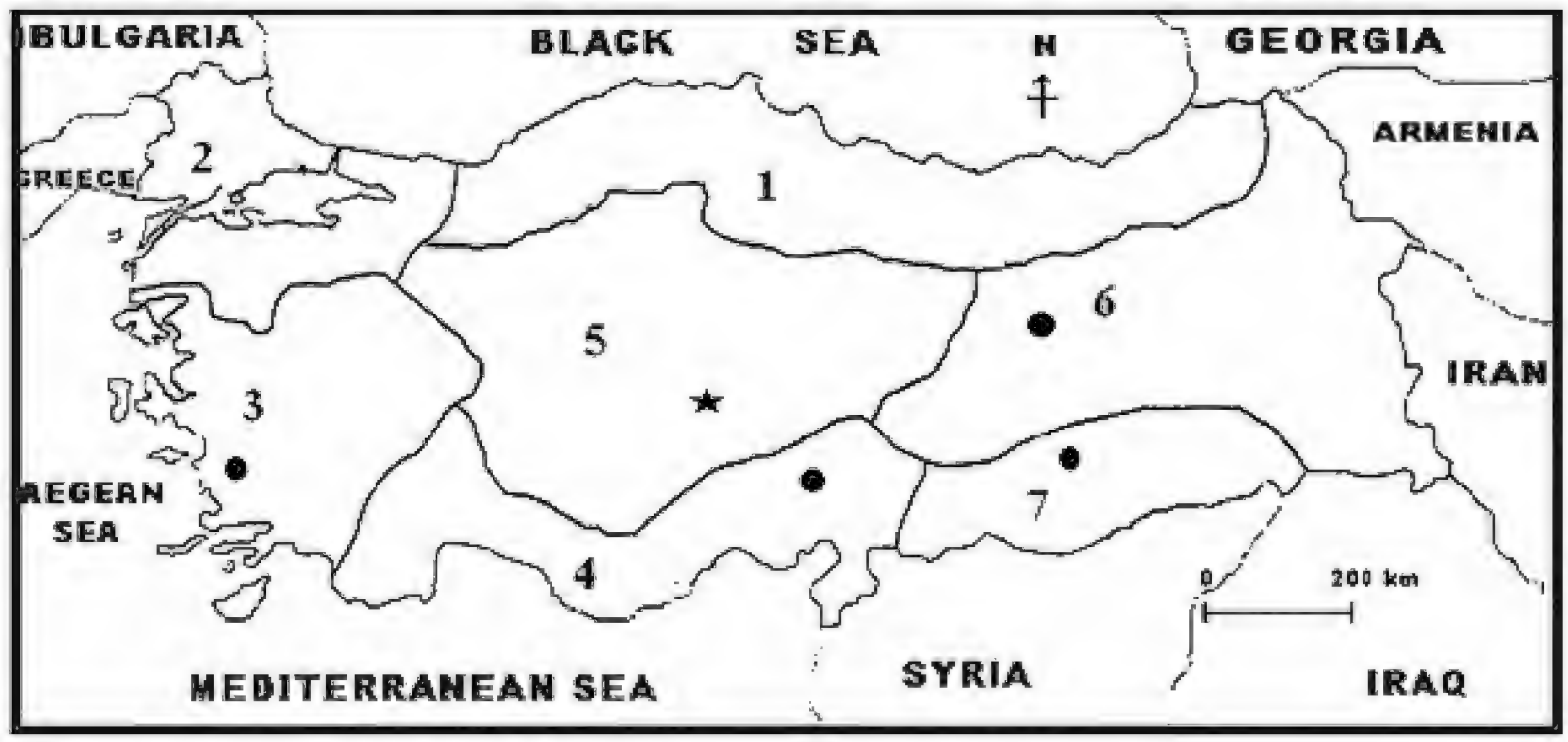

Fig. 1. Localities of *Pellenes diagonalis* (Simon, 1868). Geographical regions of Turkey: 1. Black Sea Region (BSR). 2. Marmara region (MR). 3. Aegean region (AR). 4. Mediterranean region (MER). 5. Central Anatolia Region (CAR). 6. East Anatolia Region (EAR). 7. Southeastern Anatolia Region (SAR). Old localities (●) and New locality (★).

A B

Fig. 2. *Pellenes diagonalis* (Simon, 1868) ♂ habitus. A. dorsal view. B. ventral view.

Results

Pellenes diagonalis (Simon, 1868) Figs. 2-3.

Synonyms
Attus lippiens L. Koch, 1867
Attus diagonalis Simon, 1868
Attus ostrinus Simon, 1868
Pellenes ostrinus Simon, 1885

For taxonomic references, see World Spider Catalog (2022).

Collected specimens: 2♂♂, Central Anatolia Region: between Niğde Province and Aksaray Province, Hasan Mountain (38º03'28"N, 34º09'53"E), 1450 m, 28.VI.2016, Leg. Osman Seyyar & Hakan Demir.

A B

Fig. 3. *Pellenes diagonalis* (Simon, 1868) ♂ palp. A. ventral view. B. retrolateral view.

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New record of a comb-footed spider of genus *Steatoda* (Araneae: Theridiidae) from Turkish araneo-fauna

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Abstract

The theridiid spider species *Steatoda trianguloides* Levy, 1991 is reported for the first time from Turkey. Its general habitus and genitalia are illustrated. Description and collecting data of this species are also given.

Keywords: Spider, Theridiidae, *Steatoda*, Turkey.

Introduction

Theridiidae is the fourth largest family of spiders, including 2538 species (World Spider Catalog, 2022). There are 82 theridiid species known in the Turkish fauna (Danışman *et al.*, 2022), including 8 of genus *Steatoda*. The new record in this study raises the number of theridiid species known from Turkey to 83.

Material and Methods

The spiders were collected in rocky terrain and preserved in 70% ethanol. The work of Bosmans *et al.* (2019) was consulted for the identification of this species. The identification was made by means of a SZX7 Olympus stereomicroscope. Examined specimens were deposited in the NÖHUAM (Niğde Ömer Halisdemir University Arachnological Museum). The distribution of this species is given according to the World Spider Catalog (2022).

Results

Steatoda trianguloides Levy, 1991
Material examined: Erzincan Province, Kemaliye District, 3♀♀, 04.07.2008.
Description of female: Prosoma and sternum light brown, surface densely covered with small, pointed tubercles; lateral eyes touching (Fig. 1A). Chelicerae slender. Legs yellowish, tuberculate (Fig. 1A). Opisthosoma light with dark sclerotised ridges anteriorly, a few black spots posteriorly (Fig. 1B). Epigyne as in Fig. (1C).
Distribution: France (Corsica), Cyprus, Israel, Iran.

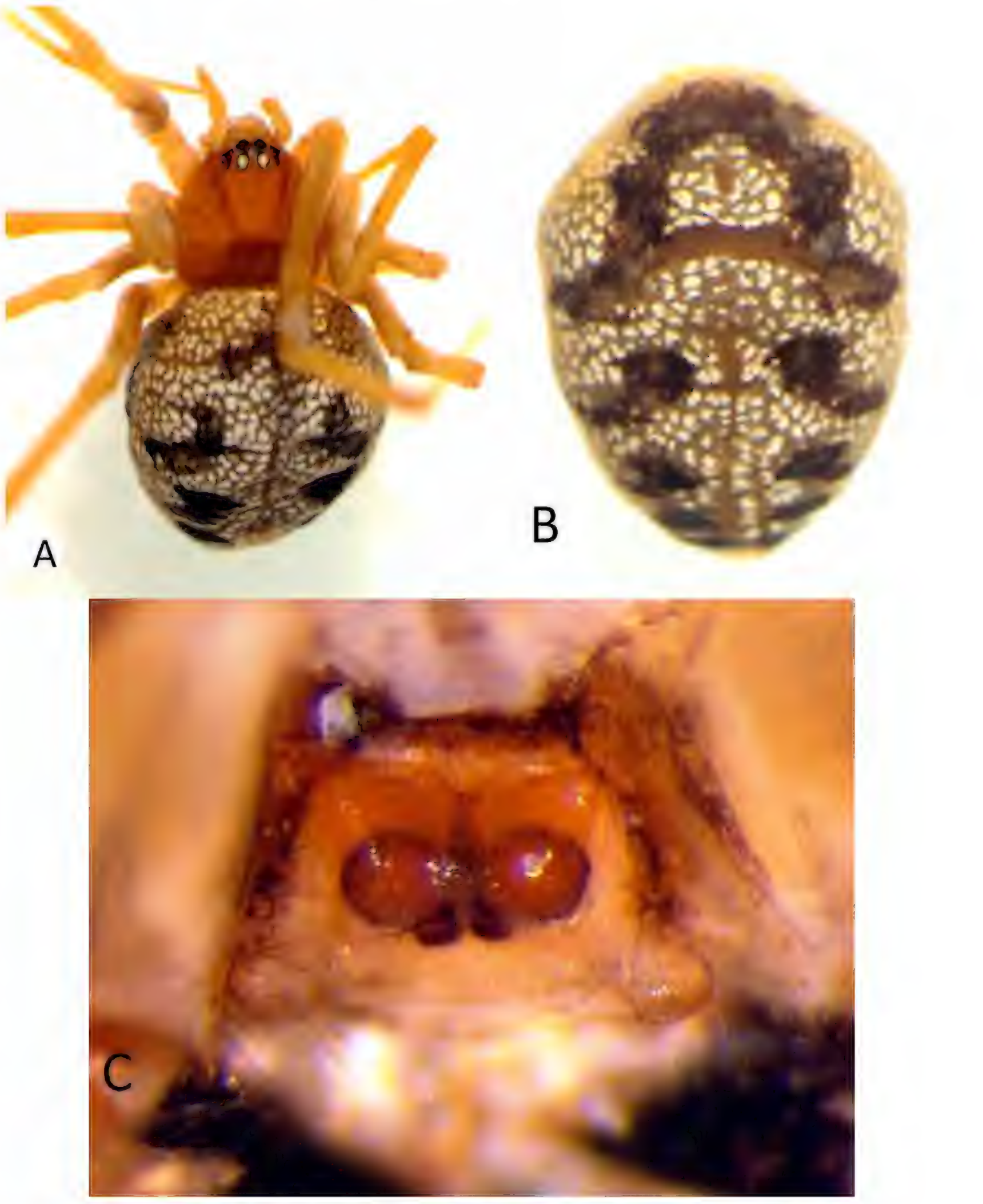

Fig. 1. *Steatoda trianguloides* ♀. A. Habitus, dorsal view. B. Opisthosoma dorsal view. C. Epigyne ventral view.

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Haplodrassus orientalis (L. Koch, 1866) (Araneae: Gnaphosidae) is a new record for the Turkish spider fauna

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Abstract

Haplodrassus orientalis (L. Koch, 1866) is recorded for the first time from Turkey. The general habitus and male genitalia are illustrated. Locality and description data of this species are also given.

Keywords: Gnaphosidae, *Haplodrassus orientalis*, new record, Turkey.

Introduction

Ground spider, Gnaphosidae, is the sixth largest family in Order Araneae and currently represented by 2414 species belonging to 144 genera worldwide (World Spider Catalog, 2022). It is now the largest spider family in Turkey. The known gnaphosid fauna of Turkey includes 158 species and 33 genera. So far 13 species of genus *Haplodrassus* Chamberlin, 1922 are known in Turkey (Topçu *et al.*, 2005; Demir & Seyyar, 2017; Danışman *et al.*, 2022). We found a new species of this genus from Turkey. The aim of this paper is to present the gnaphosid spider *Haplodrassus orientalis* (L. Koch, 1866) as a new record for the Turkish spider fauna.

Material and Methods

In this study, only two male specimens were collected from Taşköprü-Tosya road in Kastamonu Province in Turkey (Fig. 1). Examined specimens were preserved in 70% ethanol and deposited in the NÖHUAM (Niğde Ömer Halisdemir University

Arachnological Museum). In the identification, Naumova *et al.* (2021) was consulted. The identification was made by means of a SZX16 Olympus stereomicroscope.

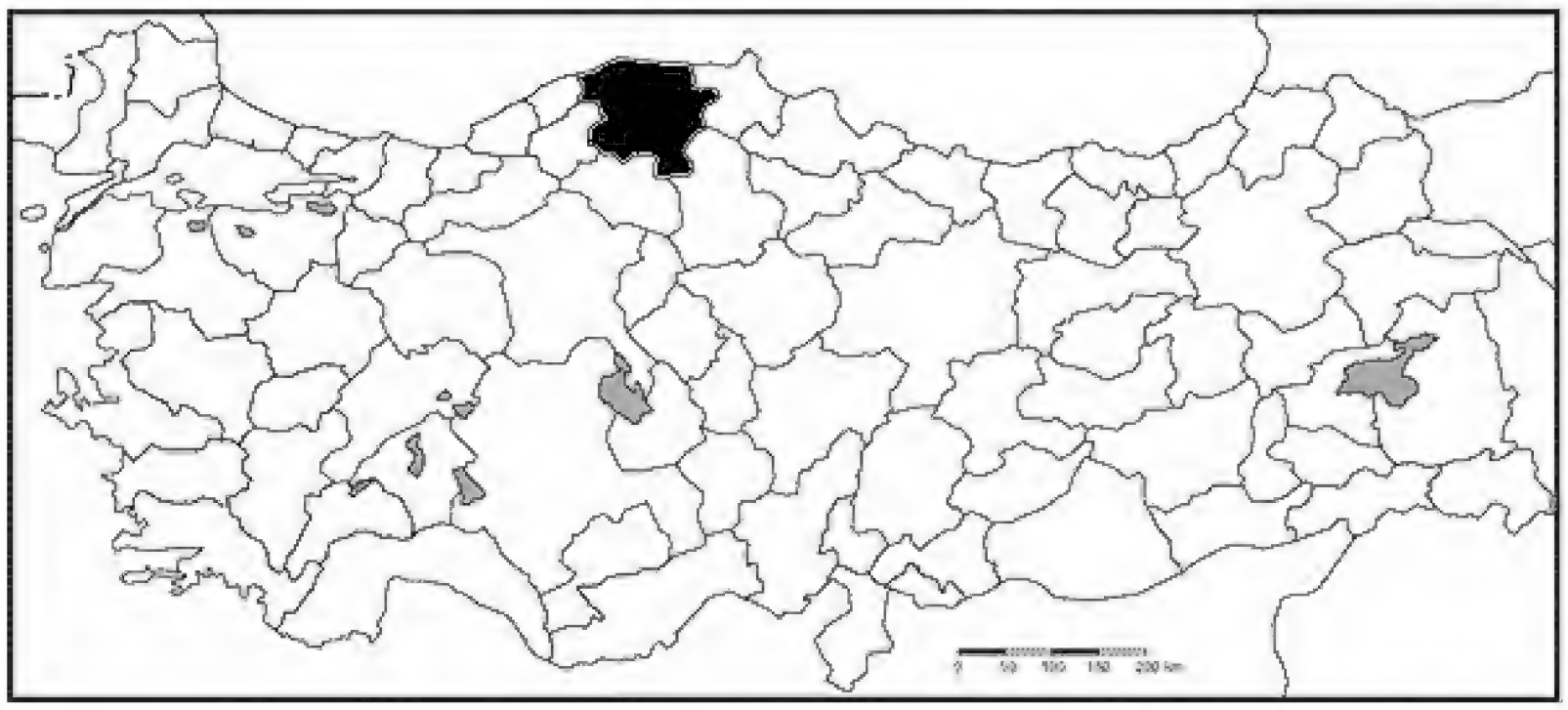

Fig. 1. Locality of *Haplodrassus orientalis* (L. Koch, 1866): Kastamonu Province in Black Sea Region of Turkey.

Fig. 2. *Haplodrassus orientalis* (L. Koch, 1866) ♂, habitus, dorsal view.

Results

Haplodrassus orientalis (L. Koch, 1866) Figs. 2-3.

Taxonomic references (World Spider Catalog, 2022)
Drassus orientalis L. Koch, 1866.
Haplodrassus isaevi Ponomarev & Tsvetkov, 2006.
Haplodrassus isaevi Piterkina & Ovtsharenko, 2007.
Haplodrassus isaevi Kovblyuk, Kastrygina & Omelko, 2012.
Haplodrassus orientalis Bosmans et al., 2018.
Haplodrassus orientalis Esyunin & Tuneva, 2020.
Haplodrassus orientalis Naumova, Blagoev & Deltshev, 2021.

Collected specimens: Turkey: Kastamonu Province: Taşköprü district, Hasanlı village (41°23'27.41"N, 34°31'22.58"E), 987 m, 20.X.2007 (2♂♂); Leg. Tuncay Türkeş.

World distribution: Bulgaria, Greece, Ukraine, Russia (Europe), Kazakhstan (World Spider Catalog, 2022).

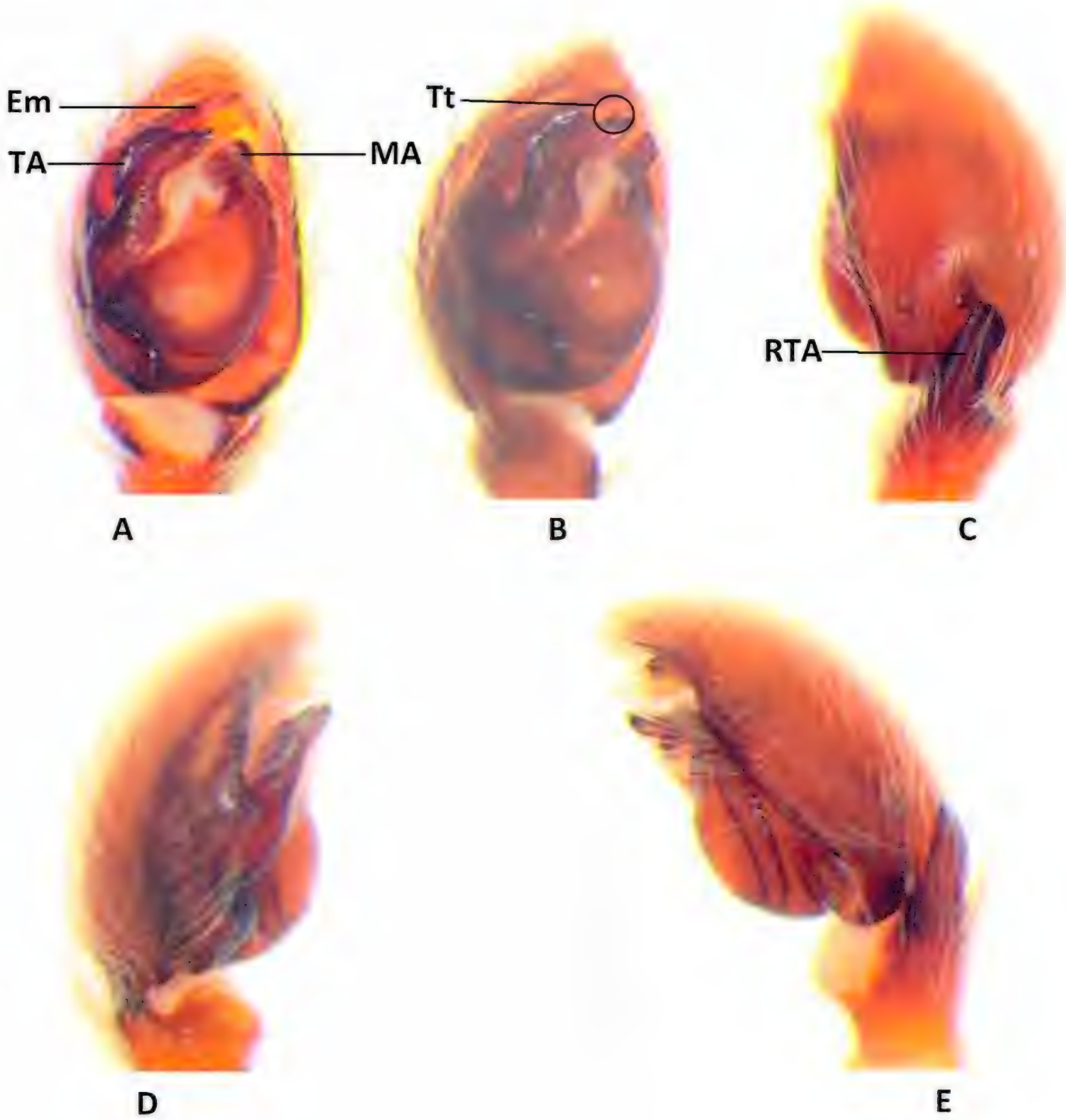

Fig. 3. *Haplodrassus orientalis* (L. Koch, 1866) ♂ palp. A-B. ventral view. C. retrolateral tibial apophysis. D. prolateral view. E. retrolateral view.
[Em = embolus, MA = median apophysis, RTA = retrolateral tibial apophysis, TA = terminal apophysis, Tt = tooth-like process of terminal apophysis (only one)].

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New record of genus *Clubiona* Latreille, 1804 (Araneae: Clubionidae) from Turkish spider fauna

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Abstract

The clubionid spider species *Clubiona pseudosimilis* Mikhailov, 1990 is reported for the first time from Turkey. Its general habitus and genitalia are illustrated. Brief description and collecting data of this species are also given.

Keywords: Spider, Clubionidae, *Clubiona*, Turkey.

Introduction

Clubionidae is a family of spiders that includes 661 species (World Spider Catalog, 2022). There are 13 species of genus *Clubiona* Latreille, 1804 known in the Turkish fauna (Topçu *et al.*, 2005; Demir & Seyyar, 2017; Danışman *et al.*, 2022). The new records in this study raises the number of clubionid species known from Turkey to fourteen.

Until now, *Clubiona pseudosimilis* Mikhailov, 1990 is known from Caucasian countries: Armenia, Azerbaijan, and Georgia (Mikhailov, 1990) and the Krasnodar and Kabardino-Balkariya regions of Russia (Mikhailov, 1992, 2003). Bosmans *et al.* (2013, 2017) expanded the distribution area to: Algeria, Portugal, Greece (Crete) (World Spider Catalog, 2022).

Material and Methods

The spiders were collected from plant region. They were preserved in 70% ethanol. The works of Mikhailov (1990) and Bosmans *et al.* (2017) were consulted for the identification of this species. The identification was made by means of a SZX7

Olympus stereomicroscope. Examined specimens were deposited in the NÖHUAM (Niğde Ömer Halisdemir University Arachnological Museum).

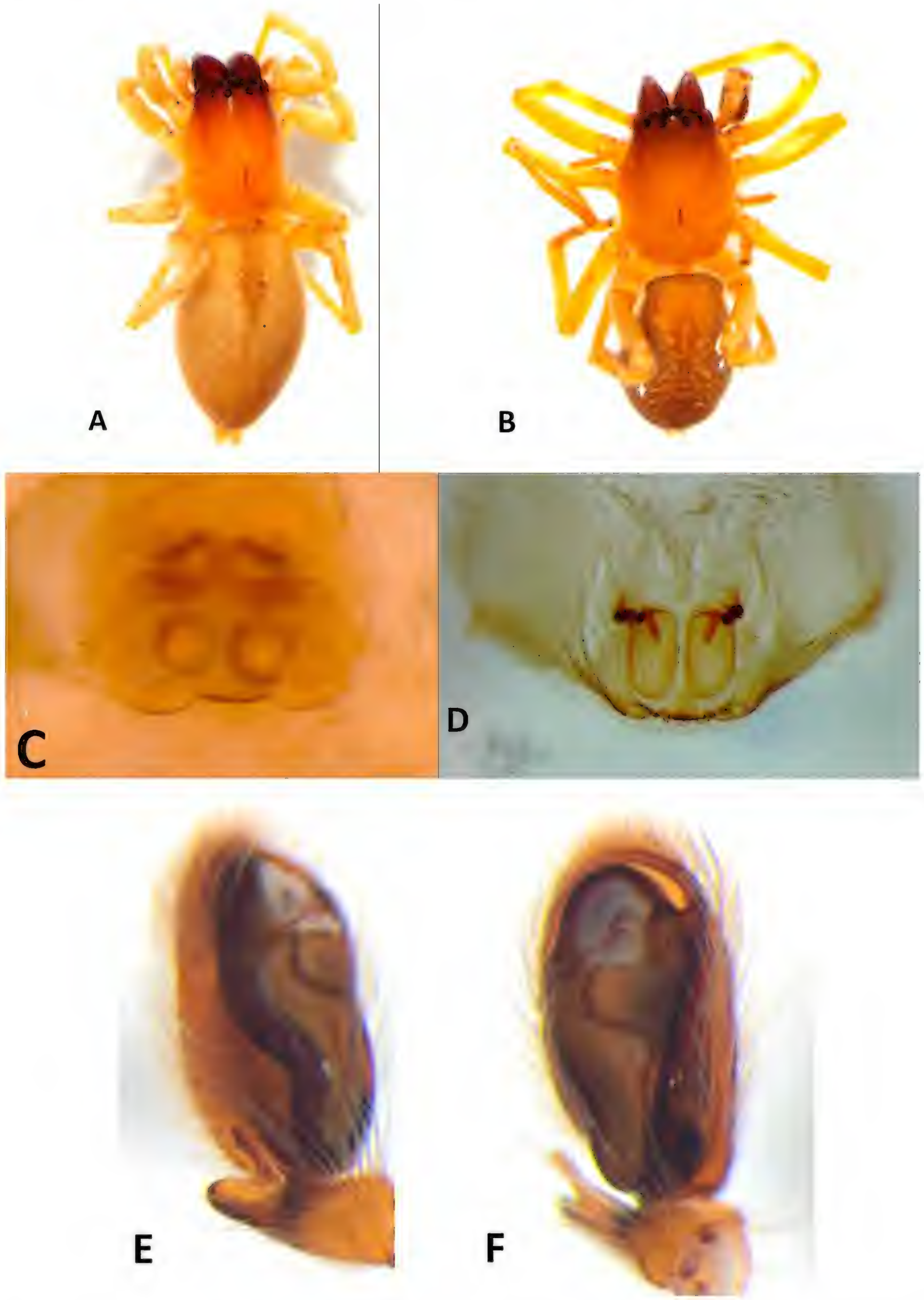

Fig. 1. *Clubiona pseudosimilis* Mikhailov, 1990. A-B. Habitus, dorsal view. A. Female. B. Male. C. Epigyne, ventral view. D. Vulva, ventral view. E-F. Male palp. E. retrolateral view. F. ventral view.

Results

Clubiona pseudosimilis Mikhailov, 1990
Clubiona pseudosimilis Mikhailov, 1990: 311, f. 16-20 (D♂♀).
Clubiona pseudosimilis Bosmans *et al.*, 2017: 22, f. 103-110 (♂♀).

Material examined: Artvin Province, Yusufeli District, Olgunlar plateau, 2467 m, 2♂♂ 3♀♀, 10.09.2009, Leg. T. Türkeş. Rize Province, Çamlıhemşin District, Elevit plateau, 1881 m, 1♂ 2♀♀, 25.06.2015, Leg. T. Türkeş. Rize Province, İğdere District, Ovit passage, 2671 m, 2♂♂ 2♀♀, 01.07.2009, Leg. T. Türkeş.

Description of male: Body length: 4.60-6.20 mm. Prosoma reddish, cephalic part chestnut brown (Fig. 1B). Legs yellowish coloured (Fig. 1B). Opisthosoma reddish-brown (Fig. 1B). Male palp as in Figs. (1E-1F).

Description of female: Body length: 5.30-7.12 mm. Prosoma yellow-reddish, cephalic part chestnut brown coloured (Fig. 1A). Legs yellowish coloured (Fig. 1A). Opisthosoma reddish-brown (Fig. 1A). Epigyne as in Fig. (1C). Vulva as in Fig. (1D).

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Redescription of two wolf spiders *Pardosa mukundi* Tikader & Malhotra, 1980 and *Draposa burasantiensis* (Tikader & Malhotra, 1976) (Araneae: Lycosidae)

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Abstract

India always amazes with its ecological diversity and biological wealth. Western Ghats has a pivotal role in this. The southern Indian state of Kerala's major land area comes under Western Ghats. So the taxonomic findings from the state have high significance. Lycosidae Sundevall, 1833 or wolf spiders are amazing organisms which are important to maintain ecological balance. Systematics of this group require a lot of revisions as their external morphology has less taxonomic value. Genital morphology analysis is the best way to accurately classify the spiders, especially wolf spiders. This study reports *Pardosa mukundi* Tikader & Malhotra, 1980 and *Draposa burasantiensis* (Tikader & Malhotra, 1976) for the first time from the southern Indian state of Kerala. Redescriptions of females of both species are provided with clear photographs and brief natural history.

Keywords: Arachnology, Taxonomy, New reports, Western Ghats, Kerala, India.

Introduction

Kerala, a southern Indian state is considered as a myriad of biological wealth considering its tropical climate and presence of biodiversity hotspot Western Ghats. Recent climate change related problems in the state, escalated the importance of reporting organisms from the region. Lycosidae Sundevall, 1833 (wolf spiders) is the 5th largest spider family in the world with 2440 species and 126 genera (World Spider Catalog, 2022).

Their adult body size ranges from 1 to 30 mm. They pursue diverse prey capture strategies, from permanently vagrant hunters to permanently burrowing species, and some genera are known to build permanent sheet-webs (Murphy *et al.*, 2006). Wolf spiders may also show very specific microhabitat preferences and may be susceptible to changes in habitat structure (Jõgar *et al.*, 2004; Marshall & Rypstra, 1999). *Pardosa* C.L. Koch, 1847 is the most diverse genus and *Draposa* Kronestedt, 2010 is a relatively new lycosid genus. Morphologically, they are very similar, they only differ by genital characters. Because of the presence of a biodiversity hotspot, it is obvious that the lycosid diversity would be much higher than this. In this paper we are dealing with the redescription of *Draposa burasantiensis* (Tikader & Malhotra, 1976) and *Pardosa mukundi* Tikader & Malhotra, 1980. It is also the second ever report of the latter species from India.

Material and Methods

All specimens were collected by hand picking method and preserved in 70% ethanol and were studied, photographed, and measured using a Leica M205C stereomicroscope, a Leica DFC450 Camera, and LAS software (Ver.4.13). Female epigynes were dissected and internal genitalia were cleared in 10% potassium hydroxide (KOH) solution. Ocular measurements were taken after placing the specimen dorsally. Leg measurements are shown as: total length (femur, patella and tibia, metatarsus, tarsus). All measurements are given in millimetres (mm).

Abbreviations used in the main text are: ALE = anterior lateral eye, AME = anterior median eye, BS = base of septum, CATE = Centre for Animal Taxonomy and Ecology, CD = copulatory duct, CO = copulatory opening, FD = fertilization duct, MOQ = median ocular quadrangle, PLE = posterior lateral eye, PME = posterior median eye, Sp = spermatheca, SS = septal stem.

Systematics

Family **Lycosidae** Sundevall, 1833

Genus ***Pardosa*** C.L. Koch, 1847

Pardosa mukundi Tikader & Malhotra, 1980 (Figs. 1A-D)
Pardosa mukundi Tikader & Malhotra, 1980: 326, f. 157-159 (♀); Buchar & Dolejš, 2021: 948, f. 17A-L (♂♀).

Distribution
Bhutan, India (First report of the species from the state of Kerala).

Material examined
India, Kerala: 2♀♀ from grassland Gavi, Pathanamthitta district, Kerala, 9º43.49'N, 77º16.01'E, alt. 3398.95 ft, 8 October 2021, coll. Abhijith, R.S. Deposited in CATE, Christ College, Irinjalakuda, Kerala, India (CATE588504).

Redescription
Female (Figs. 1A-B): Total length 4.18. Prosoma 2.28 long, 1.77 wide. Opisthosoma 1.90 long, 1.71 wide. Carapace brown with a non-prominent longitudinal fovea. Fovea long, uniform in width. Light brown spots along lateral edges of carapace. Median band dark brown, uniform throughout. Lateral bands indistinct. A small bifurcated mark in the ocular area, obscure by the presence of white pubescence. Ocular area dark, except bifurcated mark, black and white hairs present. Two long distinct, forward facing, white hairy

structure present near posterior median eyes. Head region flanked steep without any projections.

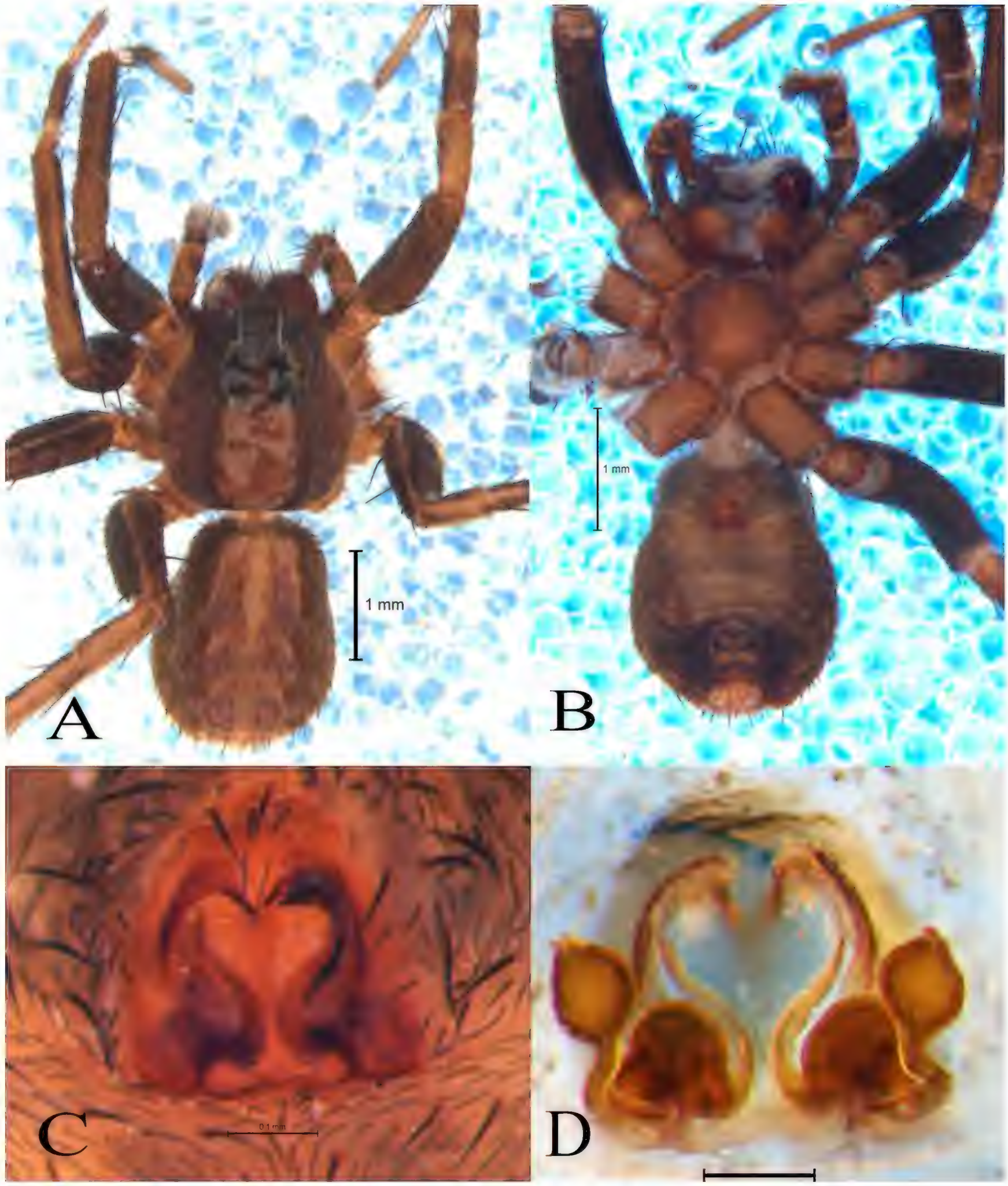

Fig. 1. *Pardosa mukundi* Tikader & Malhotra, 1980, female from Gavi, Pathanamthitta, Kerala. A-B. Female, habitus. A. dorsal view. B. ventral view, *in situ*. C-D. Epigyne. C. ventral view. D. dorsal view, cleared. (Scale bars: A-B. 1 mm, C-D. 0.1 mm).

Eye sizes and inter-distances: AME 0.079, ALE 0.049, PME 0.183, PLE 0.131, AME-AME 0.067, AME-ALE 0.037, PME-PME 0.248, PME-PLE 0.266. MOQ wider posteriorly**.** Clypeus height 0.23. Labium dark brown, wider than long. Chelicera with 3 promarginal and 3 retromarginal teeth. Sternum, light brown, heart-shaped, clothed sparsely with black hairs. Legs brown, femur darker. Leg measurements: I 3.92 (1.10, 1.37, 0.97, 0.48); II 3.88 (0.70, 1.83, 0.74, 0.61); III 3.70 (0.77, 1.89, 0.72, 0.32); IV 5.06 (1.22,

1.54, 1.32, 0.98). Leg formula: 4123. Palp 1.52 (0.49, 0.71, 0.32). Opisthosoma long oval. Dorsum dark brown with several lateral bands at downward angle. A slender yellow lanceolate pattern present medially. Venter light brown. Posterior spinnerets larger than anterior ones.
The female epigynum (Fig. 1E): distinct from other species of *Pardosa* by: long vase-shaped septum and two prominent hoods present, BS with bulges on both lateral ends. Internal genitalia (Fig. 1F): septum heart shaped, SS wider apically and medially, extreme narrow approaching BS; CD positioned laterally to lower end of SS, bulbous, opening to CO at base; Sp with long, slender stalk and globular head, positioned adjacent to CD.

Genus ***Draposa*** Kronestedt, 2010

Draposa burasantiensis (Tikader & Malhotra, 1976) (Figs. 2A-D)
Pardosa burasantiensis Tikader & Malhotra, 1976: 130, figs. 10-12 (♂♀); Tikader & Malhotra, 1980: 338, figs. 183-186 (♂♀); Tikader & Biswas, 1981: 55, figs. 88-89 (♀); Yin *et al.*, 1997: 239, figs. 112a-g (♂♀) (misidentified as per Kronestedt, 2010: 34); Song, Zhu & Chen, 1999: 330, fig. 194C (♀) (misidentified per Kronestedt, 2010: 34); Yin *et. al.*, 2012: 833, figs. 416a-g (♂♀).
Draposa burasantiensis Dhali *et al.*, 2012: 1202 (♂♀); Sen *et al.*, 2015: 48, figs. 198-202 (♀); Dhali, Saha & Raychaudhuri, 2017: 71, figs. 327-331, pl. 23 (♂).

Distribution
China, India (First report from the state of Kerala).

Material examined
India, Kerala: 2♀♀ from grassland in Gavi, Pathanamthitta district, Kerala, 9º43.49'N, 77º16.01'E, alt. 3398.95 ft, 8 October 2021, coll. Abhijith, R.S. Deposited in CATE, Christ College, Irinjalakuda, Kerala, India (CATE583912).

Redescription
Female (Figs. 2A-D): Total length 4.07. Prosoma 2.04 long, 1.62 wide. Opisthosoma 2.03 long, 1.21 wide. Carapace yellowish brown with distinct longitudinal fovea. Fovea non-uniform in width, rather wider at both ends. Green continuous spots along the margin of carapace. Median band greenish yellow, broader near ocular area and narrower around the pedicel. A small bifurcated extension of median band trespassed into the dark ocular area. Paramedian bands broad, dark greenish brown, uniform in width, with a few protrusions extended towards median band. Ocular area black and hairy except bifurcated extension of median band. Head region flanked steep without any projections. Eye sizes and inter-distances: AME 0.069, ALE 0.051, PME 0.178, PLE 0.140, AME-AME 0.070, AME-ALE 0.042, PME-PME 0.256, PME-PLE 0.290. Anterior eye row slightly procurved. MOQ wider posteriorly**.** Clypeus height 0.15. Labium longer than wide. Chelicera with 3 promarginal and 3 retromarginal teeth. All promarginal teeth subequal in length. Middle retromarginal teeth large and distinct. Sternum heart-shaped, clothed sparsely with black hairs. Dark band along the margin of sternum. Legs yellow with dark greenish yellow annuli. Leg measurements: I 5.49 (1.55, 1.90, 1.24, 0.80); II 5.38 (1.47, 1.89, 1.11, 0.91); III 5.09 (1.37, 1.66, 1.31, 0.75); IV 7.69 (1.87, 2.40, 2.33, 1.09). Leg formula: 4123. Palp 1.96 (0.66, 0.76, 0.54). Opisthosoma long oval. Dorsum dark yellowish brown with several lateral bands like patterns. Bright patterns visible on fresh specimens. Venter yellow. Posterior spinnerets larger than anterior ones.
Female epigynum (Fig. 2C): very distinct from other species of Lycosidae by presence of short tongue-like septum and V-shaped hood. Internal genitalia (Fig. 2D): SS, short,

cylindrical, uniformly wide; base of septum wider than usual; CD, globular, positioned laterally to SS; Sp subequal in length and width, positioned upright with a narrow inward angle and parallel to the SS, tip positioned parallel, much higher than the septal hood. FD small, globular near the base of CD.

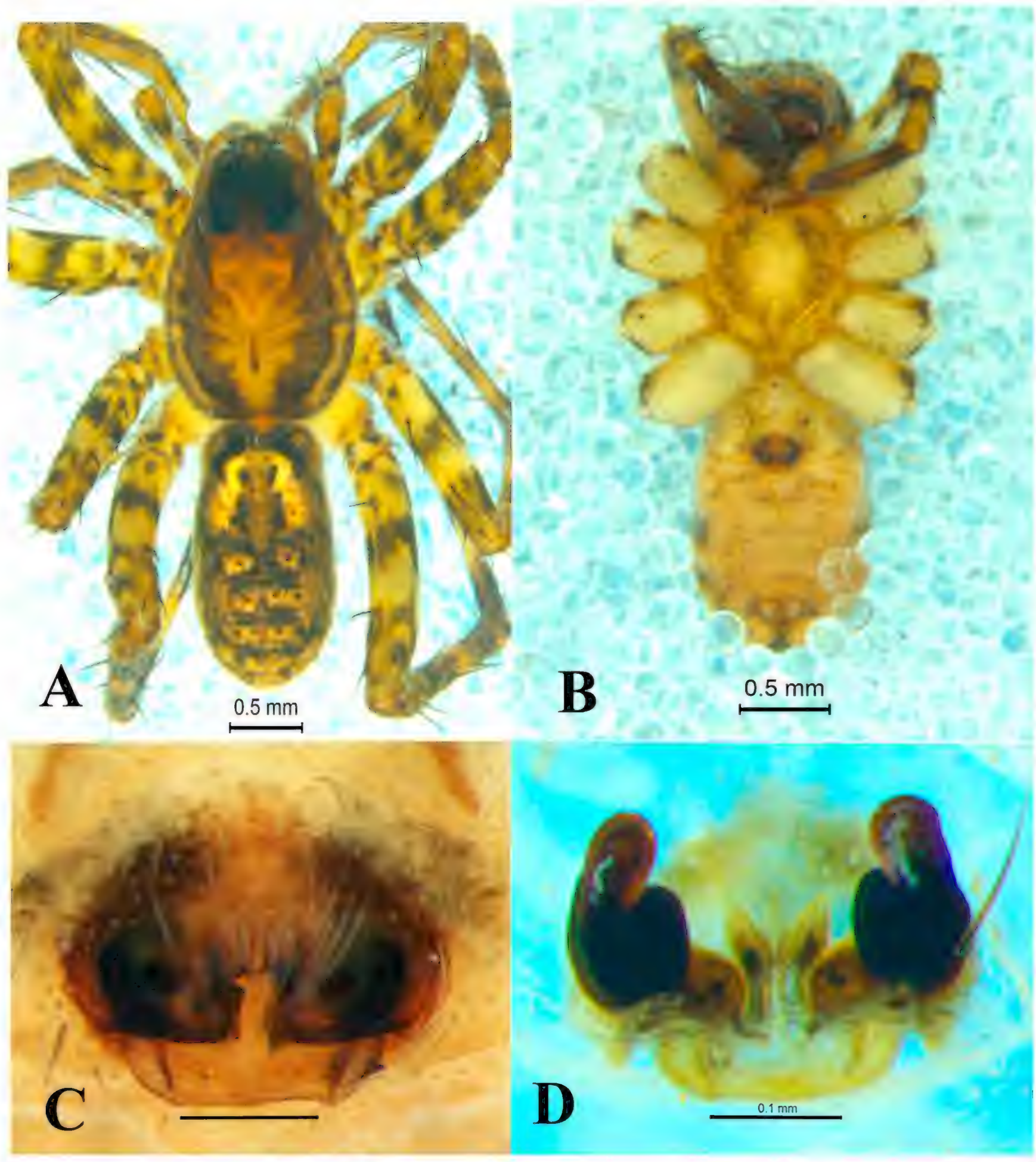

Fig. 2. *Draposa burasantiensis* (Tikader & Malhotra, 1976), female from Gavi, Pathanamthitta, Kerala. A-B. Female, habitus. A. dorsal view. B. ventral view. C-D. Epigyne. C. ventral view, *in situ*. D. dorsal view, cleared. (Scale bars: A-B. 0.5 mm, C-D. 0.1 mm).

Brief Natural history

Both species were collected from single continuous grassland. The collecting day had pleasant climate with a drizzle previous night. So the grassland is damp in some areas and dry in others. Insect population in the area is also found to be higher. Anthropogenic disturbances were also minimal. These situations were ideal for lycosids to flourish. Apart

from two species mentioned, four other lycosid species were also collected from the same area. Most of the spiders were adults. Sub adults were found, but a few. Male individuals were also scarce. But, all the collected males were sexually matured. On their natural habitat males showed great vigour, faster and active than female counterparts and spotted with raised well developed, dark coloured palp. Even though, males of *D. burasantiensis* and *P. mukundi* are not obtained, considering same habitat, guild, behaviour, presence of sexually mature females, lack of egg cases and low proportion of males, it is clear that these species are also in their mating period. The wandering nature of mature males to nearby habitats for mating may be the reason for less spotting during collecting.

Remarks

P. mukundi is a rare lycosid reported only from North India and Bhutan. But, it was not reported from south Indian states. No males were yet reported from India. The description and illustration by Tikader & Malhotra (1980) are similar to our specimen. But, that lacks genital descriptions which is taxonomically important in the taxa. Buchar & Dolejš (2021) provided photographs of female type of the species, which is similar to our specimen. We provide detailed descriptions along with photographs for getting actual account of the species.

Draposa is a relatively new lycosid genus. It is morphologically very similar to genus *Pardosa*. Female genitalia figures of *Pardosa burasantiensis* (later transferred to *Draposa*) in Tikader & Malhotra (1980) and Yin *et al.* (2012) shows similarity with our specimen. Especially view of internal genitalia and the arrangement of SS with V-shaped hoods in Tikader & Malhotra (1980) resembles our specimens in question. Descriptions in the previous papers are mainly dealt with external morphology which also matches our specimens. To get a clear picture, the redescription of the female with genitalic characters and photographs is provided by us.

Acknowledgments

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Marinarozelotes adriaticus (Caporiacco, 1951) (Araneae: Gnaphosidae) is a new spider record from Turkey

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Abstract

Marinarozelotes adriaticus (Caporiacco, 1951) is recorded for the first time from Turkey. Its general habitus and genitalia are illustrated. Description and collecting data of this species are also given.

Keywords: Gnaphosidae, *Marinarozelotes adriaticus*, new record, Turkey.

Introduction

Gnaphosidae is one of the most diverse families in Turkey and worldwide. It is the sixth largest family in Araneae and currently represented by 2414 species belonging to 144 genera worldwide (World Spider Catalog, 2022). So far, 158 species belonging to 33 genera gnaphosids are listed from Turkey (Topçu *et al.*, 2005; Demir & Seyyar, 2017; Danışman *et al.*, 2022).

Genus *Marinarozelotes* Ponomarev, 2020 includes 17 species all over the World (World Spider Catalog, 2022). So far, five species are known in Turkey: *Marinarozelotes barbatus* (L. Koch, 1866), *M. fuscipes* (L. Koch, 1866), *M. glossus* (Strand, 1915), *M. lyonneti* (Audouin, 1825), and *M. malkini* (Platnick & Murphy, 1984). We could find another species of this genus from Turkey. The aim of this paper is to present the gnaphosid spider *Marinarozelotes adriaticus* (Caporiacco, 1951) as a new record for the Turkish Spider Fauna.

Material and Methods

In this study, only two male specimens were collected from Yuva village, Kemaliye district in Erzincan Province, Eastern Anatolia Region, north-east of Turkey. Examined specimens were preserved in 70% ethanol and deposited in the NÖHUAM (Niğde Ömer Halisdemir University Arachnological Museum). For identification, Platnick & Murphy (1984) and Ponomarev & Shmatko (2020) were consulted. The identification was made by means of a SZX16 Olympus stereomicroscope.

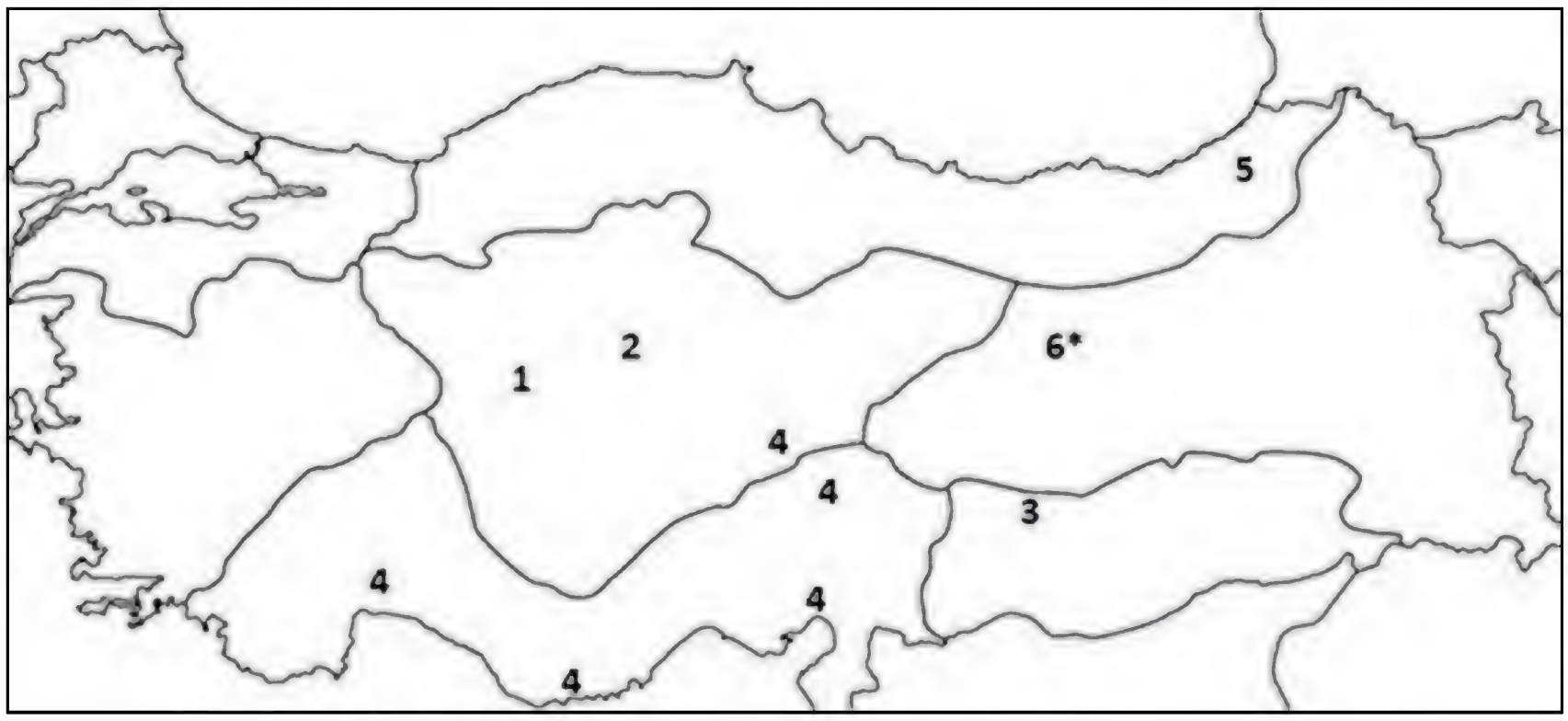

Fig. 1. Distribution of *Marinarozelotes* species in Turkey: 1. *M. barbatus*, Central Anatolia Region: Kayseri Province (Karol, 1967). 2. *M. malkini*, Central Anatolia Region: Ankara Province (Platnick & Murphy, 1984). 3. *M. fuscipes*, Southeast Anatolia Region: Adıyaman Province (Akpınar *et al.*, 2011). 4. *M. lyonneti*, Mediterranean Region: Antalya Province (Platnick & Murphy, 1984), Osmaniye Province, Kahramanmaraş Province and Mersin Province (Seyyar *et al.*, 2008), Central Anatolia Region: Kayseri Province (Seyyar *et al.*, 2008). 5. *M. glossus*, Black Sea Region: Artvin Province (Wunderlich, 2011). 6. *M. adriaticus* (new record *), Eastern Anatolia Region: Erzincan Province (in this paper).

Results

Marinarozelotes adriaticus (Caporiacco, 1951) Figs. (2,3)

Taxonomic references (World Spider Catalog, 2022)

Zelotes adriaticus Caporiacco, 1951.
Zelotes zagistus Ponomarev, 1981.
Trachyzelotes adriaticus Platnick & Murphy, 1984.
Trachyzelotes adriaticus Hu & Wu, 1989.
Trachyzelotes adriaticus Song, Zhu & Chen, 1999.
Trachyzelotes adriaticus Tuneva & Esyunin, 2002.
Trachyzelotes adriaticus Chatzaki, Thaler & Mylonas, 2003.
Trachyzelotes adriaticus Song, Zhu & Zhang, 2004.
Trachyzelotes adriaticus Ponomarev & Tsvetkov, 2004.
Trachyzelotes adriaticus Chatzaki, 2010.
Marinarozelotes adriaticus Ponomarev & Shmatko, 2020.

Fig. 2. *Marinarozelotes adriaticus* (Caporiacco, 1951) ♀, habitus, dorsal view.

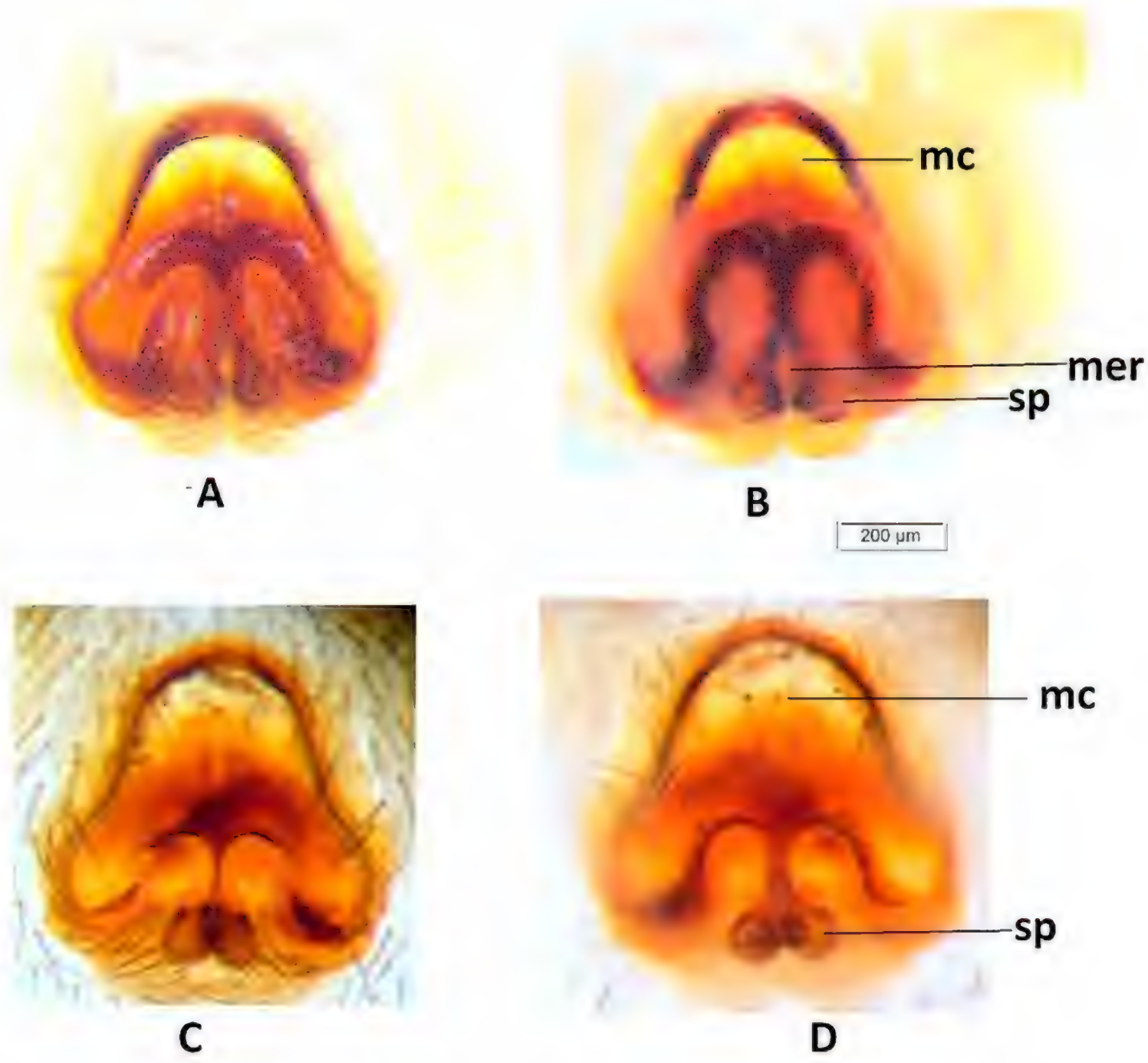

Fig. 3. A-B. *Marinarozelotes adriaticus* (Caporiacco, 1951) ♀, epigynum (our material). C-D. *Marinarozelotes lyonneti* (Audouin, 1825) (Turkish spider material). [mc = median cavity, mer = median epigynal ridge, sp = spermatheca].

Collected specimens: Turkey: Kemaliye Province: Kemaliye district, Yuva village (39°14'50.2512"N, 38°30'37.6128"E), 1130 m, 05.VII.2009 (2♀♀); Leg. Tuncay Türkeş.

World distribution: Portugal, Italy to China (World Spider Catalog, 2022).

Comments: *Marinarozelotes adriaticus* female seems very clos to *M. lyonneti* because they have the m-shaped epigynum, but it can be distinguished from *M. lyonneti* by having longer median epigynal ridges. It has nearly extended anterior epigynal ducts. Also, in *M. lyonneti* spermathecae are touchıng each other and median cavity is wide while in *M. adriaticus* they are separated and the median cavity is narrow.

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First report of *Zelotes laetus* (O. Pickard-Cambridge, 1872) (Araneae: Gnaphosidae) in Turkey

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Abstract

The gnaphosid spider species *Zelotes laetus* (O. Pickard-Cambridge, 1872) is recorded for the first time from Turkey. Its morphology is briefly described and illustrated.

Keywords: Araneae, Gnaphosidae, new record, Turkey.

Introduction

Gnaphosidae Banks, 1892 is one of the largest families of spiders with 2414 described species (World Spider Catalog, 2022). A total of 159 species in 33 genera of Gnaphosidae are known in Turkey along with recent studies (Coşar *et al.*, 2017a, b; Coşar & Danışman, 2019, 2020, 2021; Danışman *et al.*, 2020, 2022; Demir & Seyyar, 2017). In this paper, we add one gnaphosid spider species as a new record to the spider fauna of Turkey.

Material and Methods

Two samples were found under stones and collected with hand aspirator from Kahramanmaraş province in Turkey. Diagnosis and photography of the samples brought to the laboratory were made with Leica S8APO Stereomicroscope and Canon EOS 250D camera connected to it. In order to get clearer pictures of the species, many pictures were taken with different points in focus. Images were stacked using 'Combine ZM' image

stacking software and edited with the 'Photoshop CC 2019' software. The female copulatory organ was dissected, cleaned, and kept in lactic acid for 2-3 days. The map of species distribution was prepared using SimpleMappr program (Shorthouse, 2010) (Fig. 7). Specimens are deposited in the Arachnological Museum of Kırıkkale University (KUAM). All measurements are in millimetres. Abbreviations: Fe = femur, Mt = metatarsus, Pa = patella, Ta = tarsus, Ti = tibia, TL = total length. Identification depended on Wunderlich (2011).

Results

Family **Gnaphosidae** Banks, 1892
Genus ***Zelotes*** Gistel, 1848

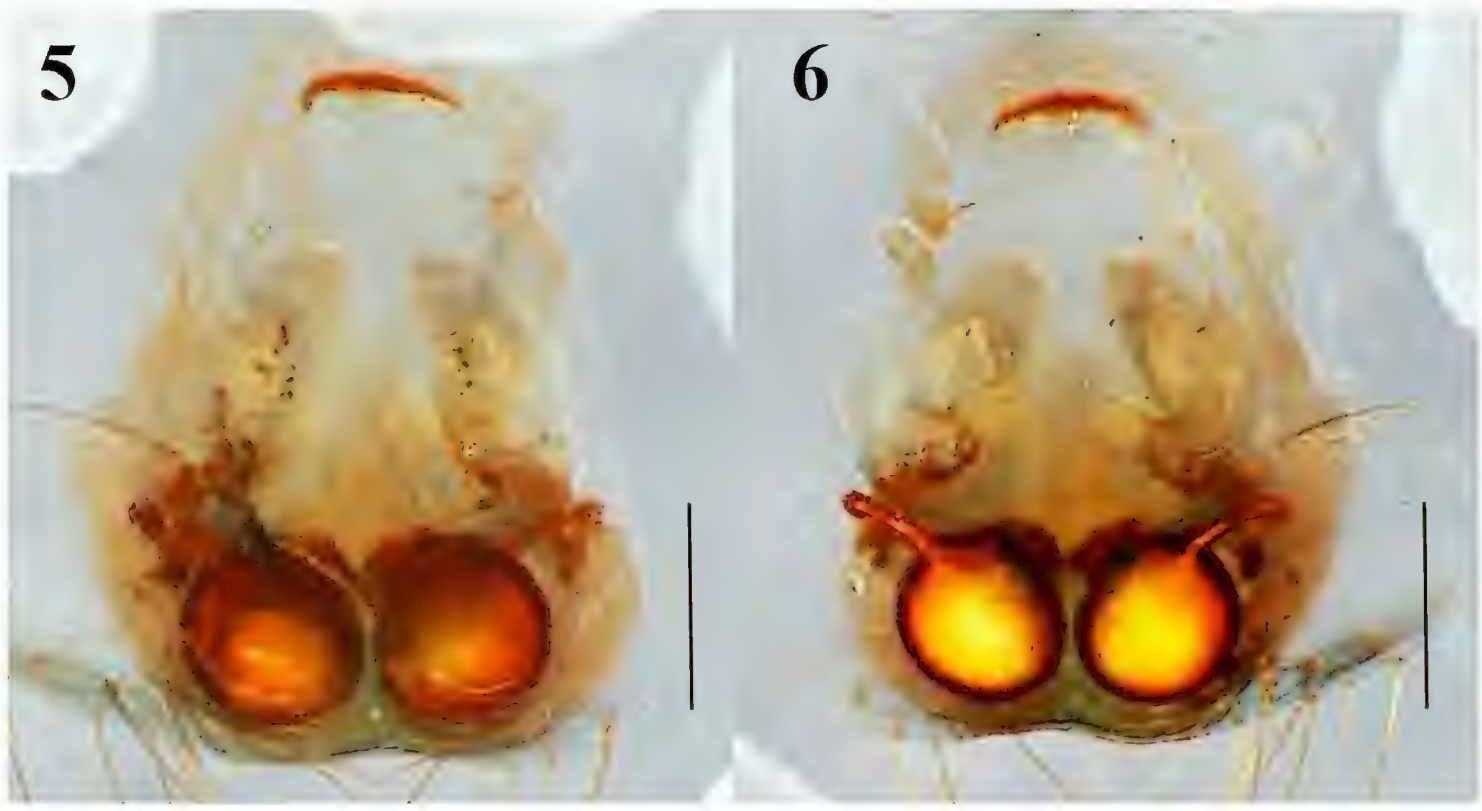
Zelotes laetus (O. Pickard-Cambridge, 1872)

Material examined: 2♀♀, Kahramanmaraş Province, Andırın District, 37°31'45"N, 36°21'57"E, elev. 614 m, 03.07.2020, Leg. T. Danışman, under stones.

Description of female (Figs. 1-6)
Measurements: Total length 5.20. Prosoma 1.80 long, 1.40 wide. Abdomen 3.4 long, 1.9 wide. Ocular area long 0.3. Epigyne 0.5 long. Chelicerae 0.65 long, 0.35 wide. Sternum 1.05 long, 0.85 wide. Leg formula IV-I-II-III. Lengths of legs: Leg I: Fe 1.40, Pa 0.90, Ti 1.20, Mt 0.85, Ta 0.80, TL 5.15; Leg II; Fe 1.20, Pa 0.65, Ti 0.95, Mt 0.80, Ta 0.70, TL 4.30; Leg III; Fe 1.05, Pa 0.55, Ti 0.80, Mt 0.80, Ta 0.65, TL 3.85; Leg IV; Fe 1.50, Pa 0.80, Ti 1.25, Mt 1.50, Ta 0.80, TL 5.85. Prosoma dark brown, with dark setae (Fig. 1). Clypeus low, dark brown. Chelicerae long, dark brown, dorsally with long, dark setae (Fig. 4). Sternum light brown, edges dark with short dark setae (Fig. 2). Abdomen blackish grey or sepia, dorsally with short setae (Fig. 1). Spinnerets grey (Figs. 1-2). Metatarsus and tarsus yellowish brown, the remaining parts of legs dark brown, covered with short dark-coloured hairs (Figs. 1-3). Epigyne long, anterior pocket narrow, with a single anterior margin, median plate barely visible ventrally (Figs. 5-6).

Distribution: North Africa to Senegal and Kenya, Portugal, France, Israel, Saudi Arabia. Introduced to Hawaii, USA, Mexico, Peru (World Spider Catalog, 2022).

Figs. 1-4. *Zelotes laetus*, female, habitus. 1. dorsal view. 2. ventral view. 3. lateral view. 4. frontal view. (Scale bars: Figs. 1-3. 1.0 mm, Fig. 4. 0.2 mm).



Figs. 5-6. *Zelotes laetus*, female, epigyne. 5. ventral view. 6. dorsal view. (Scale bars: 0.2 mm).

Fig. 7. Distribution of *Zelotes laetus* (red star) in Turkey.

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A new record of the genus *Tegenaria* from Turkey (Araneae: Agelenidae)

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Abstract

A new record of the genus *Tegenaria* Latreille, 1804, *Tegenaria euxinica* Dimitrov, 2022, is identified as a new record for the Turkish araneofauna. Its morphology is briefly described and illustrated.

Keywords: Araneae, Agelenidae, *Tegenaria*, fauna, new record, Turkey.

Introduction

Agelenidae C.L. Koch, 1837 is currently represented by 1362 species belonging to 90 genera in the world (World Spider Catalog, 2022). There are 69 species in 15 agelenid genera listed for Turkey; 35 of them belong to the genus *Tegeneria* Latreille, 1804 (Danışman et *al*., 2022). In this study, *Tegenaria euxinica* Dimitrov, 2022 is recorded for the first time from Turkey. Therefore, the known species of the genus *Tegenaria* is raised to 36 in Turkey.

Material and Methods

The specimens were collected by hand aspirator from caves in Tekirdağ and Kırklareli provinces. They were preserved in 70% ethanol. SZX16 Olympus binocular stereomicroscope was used during identification. Examined specimens were deposited in the Arachnology Museum of Niğde Ömer Halisdemir University (NÖHUAM). Measurements are in millimetres. Identification depended on Dimitrov *et al.* (2022).

Results

Tegenaria euxinica Dimitrov, 2022 (Figs. 1A-G)

Material examined: Turkey, Tekirdağ province, Saray district, Kavacık village, Koca-II cave (İsli cave), (41°02'52.4”N, 28°58'31.2”E), 537 m., 22.09.2014, 1♀,1♂; Tekirdağ province, Saray district, Bahçeköy, Ceneviz cave, (41°29'50.7”N, 27°55'03.7”E), 179 m., 23.09.2014, 1♀; Kırklareli province, Vize district, Hamidiye village, Kurudere-II cave, (41°38'56.9”N, 27°58'27.8”E), 139 m., 25.09.2014, 1♀; Kırklareli province, Vize district, Kışlacık village, Kovantaşı cave, (41°42'20.9”N, 27°54'41.0”E), 224 m., 25.09.2014, 1♀ , 26.05.2015, 6♀♀. Leg. A. Topçu. Deposited in the NÖHUAM.

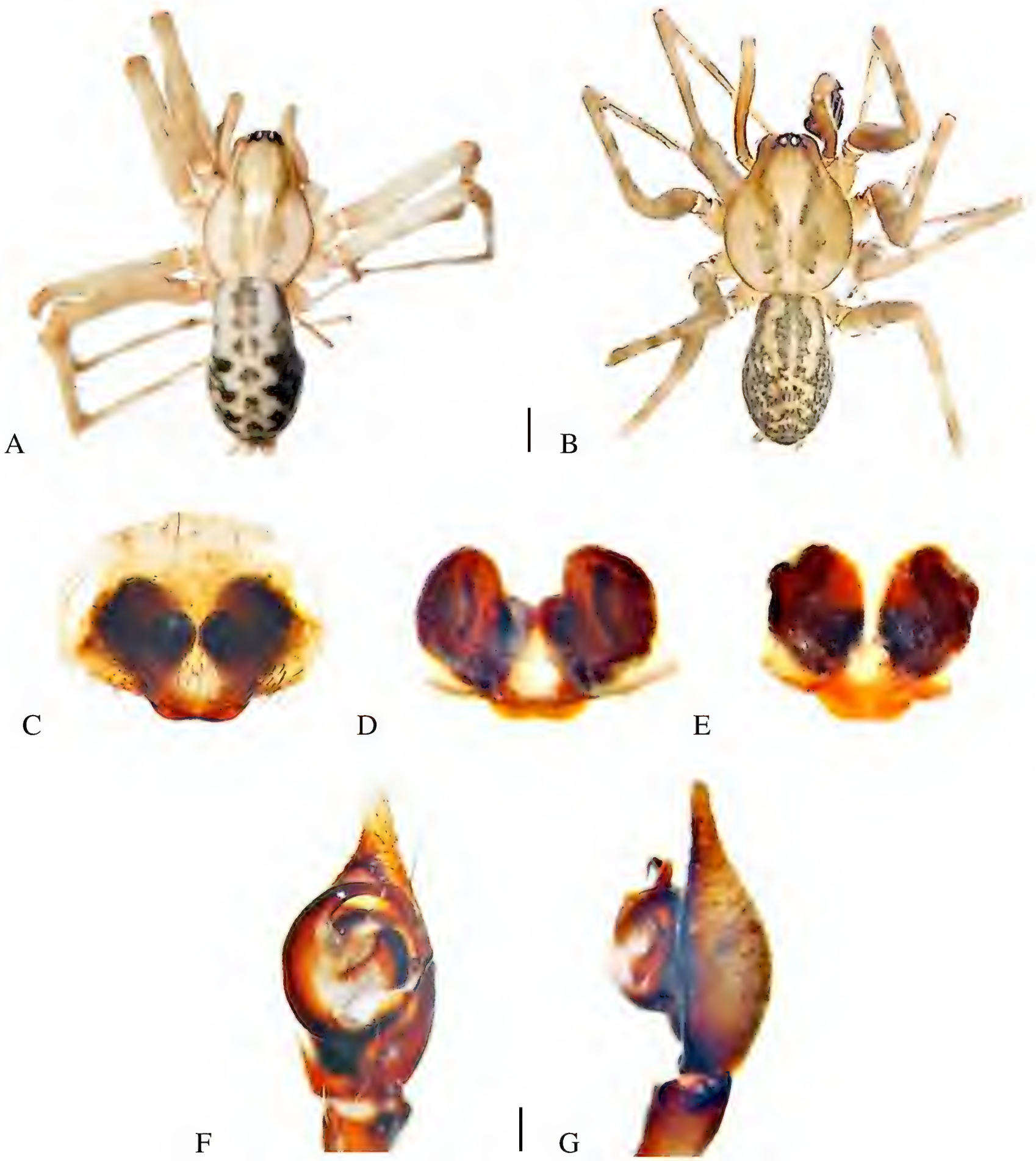

Fig. 1. *Tegenaria euxinica* Dimitrov, 2022. A-B. Habitus, dorsal view. A. female. B. male. C. Epigyne, ventral view. D-E. Vulvae, dorsal view. F-G. Left palp. F. ventral view.
G. retrolateral view. (Scale bars: A-B. 1.0 mm. C-E. 0.1 mm. F-G. 0.5 mm).

Description:
Female (Figs. 1A, C-E): Total length 8.5-9.0 mm. Carapace yellowish with 2 broad brown stripes. Abdomen greyish with brown pattern. Legs yellowish with brown rings. Epigyne: posterior sclerite trapezoid and expanding laterally. Vulvae: receptacles large and elliptic.

Male (Figs. 1B, F-G): Total length 8.5 mm. Carapace yellowish with 2 broad brown stripes. Abdomen yellowish with brown pattern. Legs yellowish with brown rings. Palp: lateral margin of conductor with a bent in a sharp angle, median apophysis with wider apical and ending in a hook shape.

Distribution: Bulgaria (World Spider Catalog, 2022) and Turkey.

Specimens of the studied species have been previously recorded as *Tegenaria percuriosa* from the European part of Turkey by Demircan & Topçu (2016) due to misidentification.

In this study, *Tegenaria euxinica* Dimitrov, 2022 is recorded for the first time from Turkey. Therefore, the known species of the genus *Tegenaria* is raised to 36 in Turkey. The total number of species of this family recorded from Turkey is now 70 species.

Acknowledgment

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Diversity of spider fauna (Arachnida: Araneae) in different districts of Andhra Pradesh, India

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Abstract

An updated checklist of spider diversity in Andhra Pradesh is presented herewith. A total of 192 species of spiders described under 104 genera belonging to 33 families are enlisted that have been recorded/described from all 13 districts of Andhra Pradesh. The maximum number of species of spiders were recorded from Kurnool (80 species) followed by Chittoor (60 species), Kadapa (44 species), Visakhapatnam (37 species), Prakasam (33 species), Anantapur and Nellore (29 species each), Guntur (19 species), Vizianagaram (16 species) and Srikakulam (15 species) and less number of species in other districts. Total 10 species recorded from different districts of Andhra Pradesh were identified only upto generic level while 15 species seem to be misidentified. The Araneidae is the biggest family (29 species) followed by Lycosidae (22 species) and Salticidae (23 species) in Andhra Pradesh. Other families are represented by less than 20 species, 9 families are represented by single species. Most of the national parks and wildlife sanctuaries, forest areas, agricultural fields, human dwellings etc. within the state still await intensive and extensive surveys to record the spider fauna.

Keywords: Spiders, Araneae, checklist, faunal distribution, Andhra Pradesh, India.

Introduction

The members of the order Araneae (Arachnida: Chelicerata) are commonly called as spiders. Spiders are cosmopolitan (except Antarctica) in distribution and have the ability to produce silk to construct webs for trapping and wrapping preys. The appearance, ecology and biology of spiders are highly diverse. Spiders represent the

largest biomass of predatory arthropods in different agroecosystems especially against insects (Cotes *et al.*, 2018; Benamú, 2020). Indeed, they are potential biocontrol agents against insect pests as they are relatively resistant to starvation, pesticides and desiccation in agricultural ecosystems (Riechert & Lockley, 2003). The spiders also serve as a food source for an extremely diverse complex of predators-parasitoids-parasites, birds, amphibians, lizards, snakes, shrews, mice, bats, fish etc. The order Araneae consists of 50,040 species in 4,250 genera belonging to 131 families (World Spider Catalog, 2022). India having a very rich biodiversity and a tropical climate with biodiversity hotspots, has the best account so far only 1904 species belonging to 490 genera in 60 families (Caleb & Sankaran, 2022), while, Singh & Singh (2021a) listed 2344 species described under 596 genera comprising 65 families, though in this list, several species were considered cases of misidentification by the authors.

Araneological studies in Andhra Pradesh date back to Simon (1885) who described and recorded 25 species of spiders in Anantapur district followed by Pocock (1899) who described *Poecilotheria metallica* from Gooty (Anantapur district), a species declared critically endangered in Red List of IUCN (Molur *et al.*, 2008a). Later, Gravely (1924) mentioned two species of lycosid spiders: *Evippa rubiginosa* Simon, 1885 and *Pardosa pseudoannulata* (Bösenberg & Strand, 1906) from Kadapa and Chittoor districts, respectively. A decade later, Gravely (1935) described a theraphocid spider, *Neoheterophrictus madraspatanus* (Gravely, 1935) from Nagalapuram Hill located in Chittoor district (some specimens were also obtained from few places of Tamil Nadu). After a long gap, Cooke (1972) described four species of ground spiders: *Prodidomus palkai, Prodidomus papavanasanemensis*, *Prodidomus tirumalai*, and *Prodidomus venkateswarai*; Platnick & Shadab (1974) recorded *Stenochilus hobsoni* O. Pickard-Cambridge, 1871 from Chittoor district; and Tikader & Malhotra (1980) recorded nine species of wolf spiders from different districts of Andhra Pradesh. Thereafter, several species of spiders were described and recorded from different districts of Andhra Pradesh in the twentieth century (Tikader & Biswas, 1981; Patel & Reddy, 1988, 1989, 1990a, b, 1991a, b, 1993a, b; Biswas & Biswas, 1992; Reddy & Patel, 1992a, b,c,d,e, 1993a,c). Studies were continued during the current century by several araneologists such as Srinivasulu (2000), Srinivasulu *et al.* (2004a,b, 2013), Majumder (2005), Rao *et al.* (2005), Bastawade & Khandal (2006), Javed *et al.* (2010a), Ramasubba Reddy (2014, 2016), Palem *et al.* (2016), Caleb *et al.* (2015, 2017, 2020), Dhali *et al.*, 2016b) etc. who decribed/recorded hundreds of species of spiders.

Despite the ecological importance and diversity, spiders are underrepresented in conservation policies in comparison to other groups throughout the world (Milano *et al.*, 2021). For the conservation of biodiversity of the spiders of any region of the world, their proper documentation is vital as it helps in monitoring the rate of loss of species in future. Preparation of checklists of species is an essential component of systematic documentation. Hence, in view of increasing intensity of anthropogenic and climatic threats (climate change, grazing, deforestation/habitat loss, forest fires, scarcity of water, use of pesticides in agriculture, Indian agricultural practices such as burning of litter and waste of crop remains and ploughing during late May, use of mosquito repellents and larvicidal pesticides to control malaria, urbanization, development of road networks and trade (Vankhede, 2011)) to biodiversity, a cataloguing and appropriate documentation of biodiversity, especially on ignored groups like spiders, is desirable immediately (Singh & Singh, 2021b). In the continuation of checklists of spiders in Indian states (Singh & Singh, 2021b,c,d, 2022a,b; Singh & Sharma, 2022; Singh BB & Singh, 2022), the checklist of spider fauna of one of the Indian state, Andhra Pradesh is documented here.

Material and Methods

Study site: Andhra Pradesh, India: Andhra Pradesh (latitude: 12°41' to 19.07°N; longitude: 77° and 84°40'E) is a state in the south-eastern coastal region of India. It is bordered by Chhattisgarh to the north, Odisha to the north-east, the Bay of Bengal to the east, Tamil Nadu to the south, Karnataka to the west and Telangana to the north-west (Fig. 1). Telangana state was carved in 2014 from Andhra Pradesh. Its coastline is about 974 km. Andhra Pradesh consists of two major regions: Rayalaseema in the south-west and Coastal Andhra bordering the Bay of Bengal in the east and north-east. The state is administratively divided into thirteen districts, nine of which located in the Coastal Andhra and four in Rayalaseema. The state also borders Yanam, a district of Puducherry lying to the south in the Godavari delta on the eastern side of the state. The Tirumala Venkateswara Temple in Tirupati is one of the world's most visited religious sites located in Chittoor district of Andhra Pradesh. Andhra Pradesh has diverse topography ranging from the hills of Eastern Ghats and Nallamala Hills to the shores of Bay of Bengal that support different ecosystems, with the rich diversity of flora and fauna. Four rivers: the Godavari, Krishna, Penna, and Tungabhadra flow through the state and provide irrigation. The total forest cover of the state is an area of 22,862 km^2 and can be broadly divided into four major biotic provinces: Deccan Plateau, Central Plateau, Eastern Highland, and East Coastal Plains. The East Coastal plains are for the most part of delta regions formed by the Godavari, Krishna, and Penna rivers. The Rayalaseema region has semi-arid conditions having largely dry deciduous types of vegetation. The coastal plain of Andhra Pradesh consists of several mangrove swamps and palm trees on the sea coast, while thorny vegetation covers the scattered hills of the plateau. The state has many wildlife sanctuaries, national parks and zoological parks. The estuaries of the Godavari and Krishna rivers sustain dense mangrove forests. Depending on the geographical region, the climate of Andhra Pradesh varies considerably. In the coastal plain, the summer (March to June) temperatures are generally higher than the rest of the state, with temperature ranging between 20 and 41°C. The summer is followed by the monsoon season (June to October), about one-third of the total rainfall is brought by the northeast monsoon. Since the state has a long coastal belt the winter season is moderate. The winter temperature generally ranges between 12 to 30°C. Rice is the major food crop of the state along with jowar, bajra, maize, minor millet, coarse grain, many varieties of pulses, oil seeds, sugarcane, cotton, chili pepper, mango nuts and tobacco.

The present checklist is based on the published literature on the spiders from India from books, book chapters, journals, proceedings of conferences, Records of the Zoological Survey of India, Kolkata, few authentic theses, websites, and World Spider Catalog (2022) up to April 29, 2022. In most of the literature published earlier, there were several errors in the scientific names of the spiders even in the recent publications because the researches on spider taxonomy like other taxa are continued with the description of new taxa, their modified status, and the publication of other nomenclatural decisions and clarifications. If a spider species is identified only up to a generic level, it was considered as species if no other species of that genus is reported within that district. In the present checklist, attempts have been made to correct the errors in the scientific names of the spiders following World Spider Catalog (2022). Misidentified species are listed separately and excluded from the checklist.

For synonymy and endemism of valid spider species, the following references may be referred to for 25 families of spiders recorded in Andhra Pradesh, e.g. Agelenidae (Singh *et al.*, 2021), Araneidae (Singh & Singh, 2021a), Atracidae and Barychelidae

(Singh & Singh, 2020), Cheiracanthiidae (Singh *et al.*, 2020a), Clubionidae (Singh BB *et al.*, 2020), Corinnidae (Singh *et al.*, 2021), Ctenidae (Singh BB *et al.*, 2020), Eresidae (Sharma *et al.*, 2021), Gnaphosidae (Singh & Singh, 2021e), Hersiliidae (Singh *et al.*, 2020b), Homalonychidae (Singh *et al.*, 2020b), Idiopidae and Ischnothelidae (Singh & Singh, 2020), Linyphiidae (Sharma *et al.*, 2020a), Liocranidae (Sharma *et al.*, 2020b), Lycosidae (Singh, 2021a), Oecobiidae (Sharma *et al.*, 2020b), Oxyopidae (Singh, 2021b), Philodromidae (Singh & Singh, 2021f), Pholcidae (Tiwari *et al.*, 2021a), Pisauridae (Tiwari & Singh, 2021), Salticidae (Singh *et al.*, 2020c, d, e, f), Scytodidae (Singh BB *et al.*, 2021), Sparassidae (Singh, 2021c), Stenochilidae (Tiwari *et al.*, 2021b), Tetragnathidae (Singh, 2021d), Theridiidae (Singh, 2021e), Thomisidae (Singh & Singh, 2021g), Titanoecidae (Singh & Singh, 2021h), Uloboridae (Singh & Singh, 2021h), and Zodariidae (Singh & Singh, 2021h).

Results and Discussion

Total number of species recorded in different districts of Andhra Pradesh is displayed in Table (1) and Fig. (1) and seemingly misidentified species are listed in Table (2).

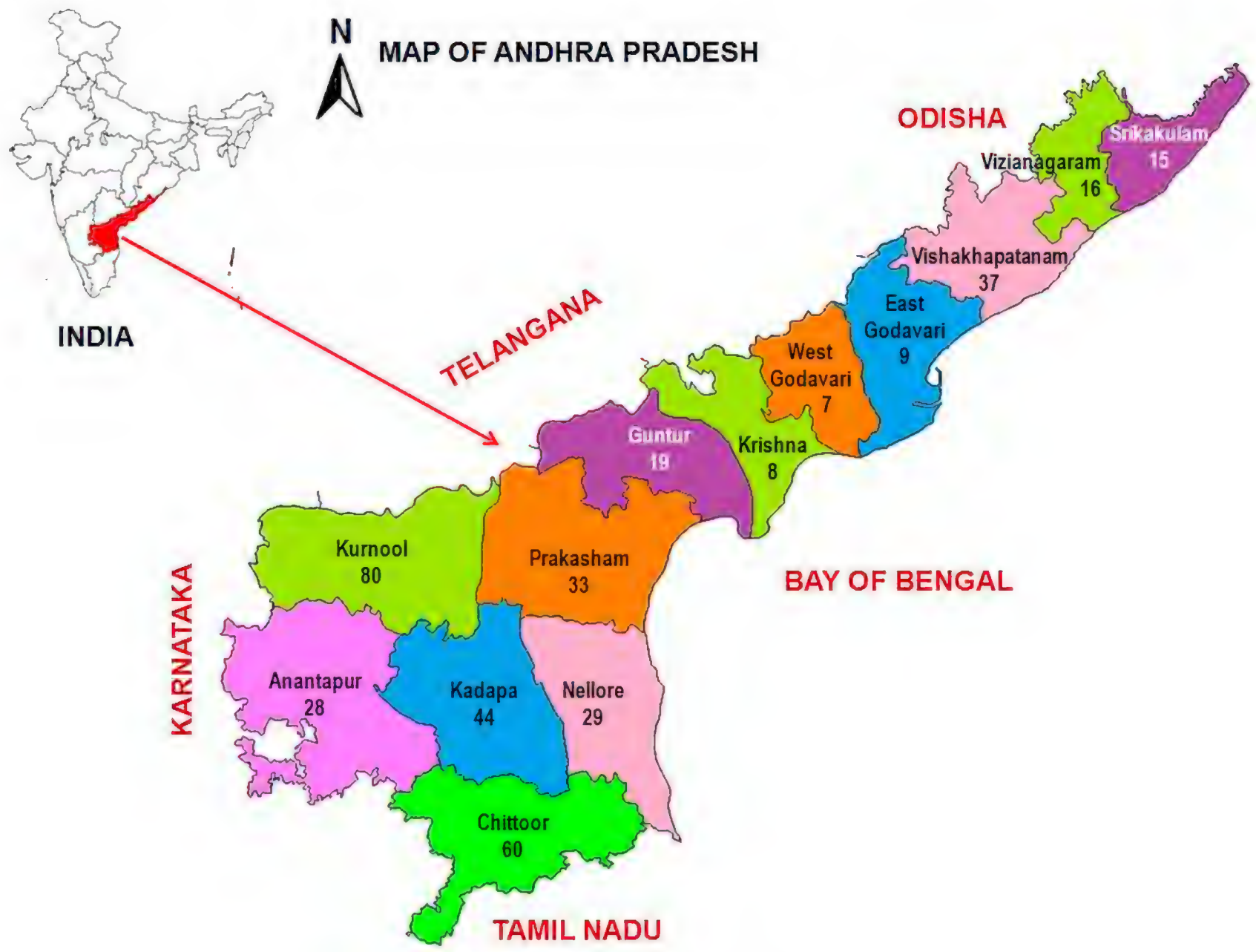

Fig. 1. Map of Andhra Pradesh showing number of species of spiders in different districts.

In the present checklist, a total of 192 species of spiders described under 104 genera belonging to 33 families are enlisted that have been recorded/described from all the 13 districts of Andhra Pradesh giving up-to-date information. It implies that about half of the families and less than 9% of the species of India are recorded in Andhra

Pradesh (Singh & Singh, 2021a; Caleb & Sankaran, 2022). No checklist of spider fauna of Andhra Pradesh is available till now. At least 30 species of spiders were described from different districts of Andhra Pradesh by Patel & Reddy (1988, 1989, 1990a, b, 1991a, b, 1993a, b) and Reddy & Patel (1992a, b, c, d, e, 1993a, b). However, Majumder (2005) recorded 25 species, Rao *et al.* (2004, 2005, 2006) mentioned 49 species, and Palem *et al.* (2016) recorded 41 species of spiders from different districts of Andhra Pradesh. Ramasubba Reddy (2014) enlisted 79 species of spiders from only Kurnool district, however, among them, 15 species seems to be misidentified and are excluded from the list. One species, *Runcinia escheri* Reimoser, 1934 was reported to occur in Andhra Pradesh (Tikader, 1971, 1980) but the locality (Masnigudi) mentioned there belong to the neighbouring Tamil Nadu state. The Araneidae is the biggest family (29 species of 258 species in India) followed by Lycosidae (26 species of 151 species in India) and Salticidae (23 species of 365 species in India). Other families are represented by less than 20 species, 9 families are represented by single species (Table 1).

Table 1. List of species of spiders recorded/described from different districts of Andhra Pradesh.

Family/Species	**Distribution**	**References**
1. Agelenidae		
Tegenaria hemanginiae Reddy & Patel, 1992	Visakhapatnam	Reddy & Patel, 1992c
2. Araneidae		
Araneus bilunifer Pocock, 1900	Chittoor, Kadapa, Nellore	Palem *et al.*, 2016
Araneus fulvellus (Roewer, 1942)	East Godavari, Guntur, Krishna, Nellore, Prakasam, Srikakulam, Vigianagaram, Visakhapatnam, West Godavari	Reddy & Patel, 1992b
Argiope aemula (Walckenaer, 1841)	Chittoor, Kadapa, Kurnool, Nellore, Prakasam	Srinivasulu *et al.*, 2004a; Rao *et al.*, 2005; Ramasubba Reddy, 2014; Palem *et al.*, 2016
Argiope anasuja Thorell, 1887	Chittoor, East Godavari, Kadapa, Kurnool, Nellore, Prakasam, Srikakulam, Visakhapatnam	Srinivasulu *et al.*, 2004a; Rao *et al.*, 2005; Javed *et al.*, 2010a; Ramasubba Reddy, 2014; Palem *et al.*, 2016
Argiope catenulata (Doleschall, 1859)	Anantapur, Visakhapatnam	Simon, 1885; Majumder, 2005
Argiope lobata (Pallas, 1772)	Anantapur, Kurnool	Simon, 1885; Srinivasulu *et al.*, 2004b; Rao *et al.*, 2005, 2006a; Ramasubba Reddy, 2014
Argiope pulchella Thorell, 1881	Chittoor, Kadapa, Kurnool, Nellore, Prakasam, Visakhapatnam	Majumder, 2005; Rao *et al.*, 2005; Palem *et al.*, 2016; Ramasubba Reddy, 2014

Family/Species	Distribution	References
Bijoaraneus mitificus (Simon, 1886)	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Cyclosa confraga (Thorell, 1892)	Chittoor, Kadapa, Nellore	Palem *et al.*, 2016
Cyrtarachne bengalensis Tikader, 1961	Visakhapatnam	Majumder, 2005
Cyrtarachne inaequalis Thorell, 1895	Visakhapatnam	Majumder, 2005
Cyrtophora cicatrosa (Stoliczka, 1869)	Kurnool	Ramasubba Reddy, 2014
Cyrtophora citricola (Forskål, 1775)	Chittoor, Kadapa, Kurnool, Nellore, Srikakulam, Vigianagaram, Visakhapatnam	Majumder, 2005; Rao *et al.*, 2005; Javed *et al.*, 2010a; Ramasubba Reddy, 2014; Palem *et al.*, 2016
Eriovixia excelsa (Simon, 1889)	Chittoor, Kadapa, Nellore	Palem *et al.*, 2016
Eriovixia laglaizei (Simon, 1877)	Kurnool, Prakasam	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Gasteracantha geminata (Fabricius, 1798)	Chittoor, Krishna, Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014; iNaturalist, 2022
Herennia multipuncta (Doleschall, 1859)	Kurnool	Ramasubba Reddy, 2014
Macracantha hasselti (C.L. Koch, 1837)	Kurnool	Ramasubba Reddy, 2014
Neoscona bengalensis Tikader & Bal, 1981	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Neoscona dhumani Patel & Reddy, 1993	Visakhapatnam	Patel & Reddy, 1993a
Neoscona mukerjei Tikader, 1980	Chittoor, Kadapa, Kurnool, Prakasam , Vigianagaram	Majumder, 2005; Rao *et al.*, 2005; Ramasubba Reddy, 2014; Palem *et al.*, 2016
Neoscona nautica (L. Koch, 1875)	Chittoor, Kadapa, Kurnool	Ramasubba Reddy, 2014; Palem *et al.*, 2016
Neoscona punctigera (Doleschall, 1857)	Chittoor, Kadapa, Nellore	Palem *et al.*, 2016
Neoscona theisi (Walckenaer, 1841)	Chittoor, Kadapa, Kurnool	Ramasubba Reddy, 2014; Palem *et al.*, 2016
Neoscona ujavalai Reddy & Patel, 1992	West Godavari	Reddy & Patel, 1992d
Neoscona vigilans (Blackwall, 1865)	Anantapur, Kurnool	Simon, 1885; Tikader & Bal, 1981; Ramasubba Reddy, 2014; Tikader & Biswas, 1981; Biswas & Biswas, 1992; Rao *et al.*, 2005

Family/Species	Distribution	References
Neoscona sp.	Srikakulam	Rao *et al.*, 1981
Nephila pilipes (Fabricius, 1793)	Kurnool, Prakasam	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Thelacantha brevispina (Doleschall, 1857)	Srikakulam	Javed *et al.*, 2010a
Zygiella sp.	Chittoor, Kadapa	Palem *et al.*, 2016
3. Barychelidae		
Sason robustum (O. Pickard-Cambridge, 1883)	Chittoor	Siliwal *et al.*, 2011
Sipalolasma arthrapophysis (Gravely, 1915)	Visakhapatnam	Javed *et al.*, 2010c; Dhali *et al.*, 2016a
4. Cheiracanthiidae		
Cheiracanthium melanostomum (Thorell, 1895)	Srikakulam	Rao *et al.*, 1981
Cheiracanthium sambii Patel & Reddy, 1991	Guntur	Patel & Reddy, 1991b
Cheiracanthium saraswatii Tikader, 1962	Chittoor, Kadapa	Palem *et al.*, 2016
Cheiracanthium seshii Patel & Reddy, 1991	Srikakulam	Patel & Reddy, 1991b
Cheiracanthium triviale (Thorell, 1895)	Andhra Pradesh	Saha *et al.*, 2016
5. Clubionidae		
Simalio aurobindoi Patel & Reddy, 1991	Guntur	Patel & Reddy, 1991b
6. Corinnidae		
Castianeira zetes Simon, 1897	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
7. Ctenidae		
Ctenus indicus Gravely, 1931	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Ctenus narashinhai Patel & Reddy, 1988	East Godavari, Visakhapatnam	Patel & Reddy, 1988; Dhali *et al.*, 2016b
Ctenus tuniensis Patel & Reddy, 1988	East Godavari, Visakhapatnam	Patel & Reddy, 1988; Dhali *et al.*, 2016b
8. Eresidae		
Stegodyphus pacificus Pocock, 1900	Chittoor, Kadapa, Nellore	Palem *et al.*, 2016
Stegodyphus sarasinorum Karsch, 1892	Kurnool, Vigianagaram	Majumder, 2005; Rao *et al.*, 2005; Ramasubba Reddy, 2014

Family/Species	Distribution	References
Stegodyphus tibialis (O. Pickard-Cambridge, 1869)	Chittoor, Kadapa, Nellore	Palem *et al.*, 2016
9. Gnaphosidae		
Drassodes luridus (O. Pickard-Cambridge, 1874)	Visakhapatnam	Majumder, 2005
Drassodes parvidens Caporiacco, 1934	Chittoor, Kadapa, Nellore	Palem *et al.*, 2016
Echemus chaperi Simon, 1885	Anantapur	Simon, 1885
Gnaphosa poonaensis Tikader, 1973	Guntur	Gajbe UA, 1988
Poecilochroa barmani Tikader, 1982	Vigianagaram	Majumder, 2005
Zelotes pexus (Simon, 1885)	Anantapur	Simon, 1885
Zelotes scrutatus (O. Pickard-Cambridge, 1872)	Anantapur	Tikader, 1982
10. Hersiliidae		
Hersilia orvakalensis Javed, Foord & Tampal, 2010	Kurnool	Javed *et al.*, 2010b
Hersilia savignyi Lucas, 1836	Anantapur, Chittoor, Kadapa, Kurnool, Nellore, Vigianagaram	Simon, 1885; Majumder, 2005; Ramasubba Reddy, 2014; Palem *et al.*, 2016
Murricia triangularis M. Baehr & B. Baehr, 1993	East Godavari	Javed & Tampal, 2010
11. Idiopidae		
Idiops crassus Simon, 1884	Anantapur	Simon, 1885
Titanidiops constructor (Pocock, 1900)	Chittoor, Guntur, Kurnool, Prakasam	Rao *et al.*, 2005; Siliwal *et al.*, 2011; Ramasubba Reddy, 2014; Ramasubba Reddy, 2016
12. Ischnothelidae		
Indothele mala Coyle, 1995	Chittoor	Coyle, 1995; Dhali *et al.*, 2016a
13. Liocranidae		
Oedignatha binoyii Reddy & Patel, 1993	Visakhapatnam	Reddy & Patel, 1993a
Oedignatha indica Reddy & Patel, 1993	Visakhapatnam	Reddy & Patel, 1993a
Oedignatha scrobiculata Thorell, 1881	Visakhapatnam	Majumder, 2005

Family/Species	Distribution	References
14. Lycosidae		
Crocodilosa leucostigma (Simon, 1885)	Anantapur	Simon, 1885
Draposa atropalpis (Gravely, 1924)	Chittoor, Kurnool, Prakasam	Tikader & Malhotra, 1980; Biswas & Biswas, 1992; Rao *et al.*, 2005; Ramasubba Reddy, 2014
Draposa lyrivulva (Bösenberg & Strand, 1906)	Visakhapatnam	Tikader & Malhotra, 1980; Tikader & Biswas, 1981
Draposa subhadrae (Patel & Reddy, 1993)	Prakasam, Visakhapatnam	Patel & Reddy, 1993b; Kronestedt, 2010; Dhali *et al.*, 2016b
Evippa rajasthanea Tikader & Malhotra, 1980	Prakasam	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Evippa rubiginosa Simon, 1885	Anantapur, Kadapa	Simon, 1885; Gravely, 1924; Tikader & Malhotra, 1980; Dhali *et al.*, 2016b
Hippasa greenalliae (Blackwall, 1867)	Kurnool, Prakasam	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Hippasa olivacea (Thorell, 1887)	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Hippasa pisaurina Pocock, 1900	Chittoor, Kadapa, Nellore	Palem *et al.*, 2016
Hippasa valiveruensis Patel & Reddy, 1993	Guntur	Patel & Reddy, 1993b; Dhali *et al.*, 2016b
Lycosa balaramai Patel & Reddy, 1993	Visakhapatnam	Patel & Reddy, 1993b; Dhali *et al.*, 2016b
Lycosa chaperi Simon, 1885	Anantapur	Simon, 1885; Tikader & Malhotra, 1980; Dhali *et al.*, 2016b
Lycosa indagatrix Walckenaer, 1837	Anantapur, Chittoor, Prakasam	Simon, 1885; Tikader & Malhotra, 1980; Rao *et al.*, 2005; Ramasubba Reddy, 2014; Dhali *et al.*, 2016b
Lycosa kempi Gravely, 1924	Kurnool, Prakasam	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Lycosa madani Pocock, 1901	Chittoor	Tikader & Malhotra, 1980; Dhali *et al.*, 2016b
Lycosa pictula Pocock, 1901	Chittoor, Kadapa	Palem *et al.*, 2016
Lycosa poonaensis Tikader & Malhotra, 1980	Chittoor, Kadapa	Palem *et al.*, 2016
Lycosa thoracica Patel & Reddy, 1993	Prakasam	Patel & Reddy, 1993b; Dhali *et al.*, 2016b

Family/Species	Distribution	References
Pardosa gopalai Patel & Reddy, 1993	East Godavari	Patel & Reddy, 1993b; Dhali *et al.*, 2016b
Pardosa heterophthalma (Simon, 1898)	Visakhapatnam	Majumder, 2005
Pardosa partita Simon, 1885	Anantapur	Simon, 1885
Pardosa pseudoannulata (Bösenberg & Strand, 1906)	Chittoor	Gravely, 1924; Tikader & Malhotra, 1980; Tikader & Biswas, 1981; Biswas & Biswas, 1992
Pardosa sumatrana (Thorell, 1890)	Chittoor, Kadapa, Kurnool, Nellore	Tikader & Malhotra, 1980; Tikader & Biswas, 1981; Biswas & Biswas, 1992; Rao *et al.*, 2005; Ramasubba Reddy, 2014; Palem *et al.*, 2016; Dhali *et al.*, 2016b
Pardosa sp.	Chittoor, Kadapa	Palem *et al.*, 2016
Serratacosa himalayensis (Gravely, 1924)	Vigianagaram	Majumder, 2005
Trochosa gunturensis Patel & Reddy, 1993	Guntur	Patel & Reddy, 1993b; Dhali *et al.*, 2016b
Wadicosa fidelis (O. Pickard-Cambridge, 1872)	Chittoor, Kadapa, Kurnool, Nellore, Prakasam, Visakhapatnam	Tikader & Malhotra, 1980; Tikader & Biswas, 1981; Biswas & Biswas, 1992; Majumder, 2005; Rao *et al.*, 2005; Ramasubba Reddy, 2014; Palem *et al.*, 2016; Dhali *et al.*, 2016b
15. Oecobiidae		
Oecobius marathaus Tikader, 1962	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Oecobius putus O. Pickard-Cambridge, 1876	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
16. Oxyopidae		
Oxyopes javanus Thorell, 1887	Srikakulam	Rao *et al.*, 1981
Oxyopes kohaensis Bodkhe & Vankhede, 2012	Kurnool	Ramasubba Reddy, 2014
Oxyopes pawani Gajbe, 1992	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Oxyopes shweta Tikader 1970	Vigianagaram	Majumder, 2005
Oxyopes sp.	Chittoor, Kadapa, Nellore, Srikakulam	Rao *et al.*, 1981; Palem *et al.*, 2016
Peucetia latikae Tikader, 1970	Visakhapatnam	Majumder, 2005
Peucetia viridana (Stoliczka, 1869)	Kurnool, Srikakulam	Rao *et al.*, 1981; Ramasubba Reddy, 2014

Family/Species	Distribution	References
Peucetia yogeshi Gajbe, 1999	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
17. Palpimanidae		
Palpimanus gibbulus Dufour, 1820	Anantapur	Simon, 1885
18. Philodromidae		
Philodromus betrabatai Tikader, 1966	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Thanatus indicus Simon, 1885	Anantapur	Simon, 1885
Tibellus elongatus Tikader, 1960	Kurnool	Ramasubba Reddy, 2014
Tibellus pashanensis Tikader, 1980	Prakasam	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Tibellus pateli Tikader, 1980	Kurnool	Ramasubba Reddy, 2014
19. Pholcidae		
Artema atlanta Walckenaer, 1837	Anantapur, Chittoor, Kadapa, Kurnool, Nellore	Simon, 1885; Rao *et al.*, 2005; Ramasubba Reddy, 2014; Palem *et al.*, 2016
Crossopriza lyoni (Blackwall, 1867)	Chittoor, Kadapa, Kurnool, Nellore,Vigianagaram	Majumder, 2005; Rao *et al.*, 2005; Ramasubba Reddy, 2014; Palem *et al.*, 2016
Pholcus phalangioides (Fuesslin, 1775)	Chittoor, Kadapa, Kurnool, Nellore	Rao *et al.*, 2005; Ramasubba Reddy, 2014; Palem *et al.*, 2016
20. Pisauridae		
Dendrolycosa bobbiliensis (Reddy & Patel, 1993)	Vigianagaram	Reddy & Patel, 1993b
Nilus decoratus (Patel & Reddy, 1990)	Guntur, Prakasam	Patel & Reddy, 1990a
Pisaura podilensis Patel & Reddy, 1990	Guntur, Prakasam	Patel & Reddy, 1990a; Dhali *et al.*, 2016b
Pisaura sp.	Chittoor, Kadapa	Palem *et al.*, 2016
21. Prodidomidae		
Prodidomus chaperi (Simon, 1884)	Anantapur	Simon, 1885
Prodidomus palkai Cooke, 1972	Chittoor	Cooke, 1972
Prodidomus papavanasanemensis Cooke, 1972	Chittoor	Cooke, 1972
Prodidomus tirumalai Cooke, 1972	Chittoor	Cooke, 1972

Family/Species	Distribution	References
Prodidomus venkateswarai Cooke, 1972	Chittoor	Cooke, 1972
22. Salticidae		
Carrhotus andhra Caleb, 2020	Visakhapatnam	Caleb *et al.*, 2020
Carrhotus viduus (C.L. Koch, 1846)	Chittoor, East Godavari, Kadapa, Krishna, Kurnool	Ramasubba Reddy, 2014; Palem *et al.*, 2016; Caleb *et al.*, 2020; iNaturalist, 2022
Chrysilla volupe (Karsch, 1879)	West Godawari	iNaturalist, 2022
Cyrba algerina (Lucas, 1846)	Anantapur	Simon, 1885
Epocilla aurantiaca (Simon, 1885)	Kurnool	Ramasubba Reddy, 2014
Epocilla calcarata (Karsch, 1880)	Kurnool	Ramasubba Reddy, 2014
Harmochirus brachiatus (Thorell, 1877)	Kurnool	Ramasubba Reddy, 2014
Hasarius adansoni (Audouin, 1825)	Srikakulam	iNaturalist, 2022
Hyllus semicupreus (Simon, 1885)	Anantapur, Krishna, Kurnool	Simon, 1885; Ramasubba Reddy, 2014; iNaturalist, 2022
Menemerus bivittatus (Dufour, 1831)	Anantapur, Kurnool	Simon, 1885; Ramasubba Reddy, 2014; iNaturalist, 2022
Myrmaplata plataleoides (O. Pickard-Cambridge, 1869)	Prakasam	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Myrmarachne melanocephala MacLeay, 1839	Kurnool	Ramasubba Reddy, 2014
Myrmarachne providens (G.W. Peckham & E.G. Peckham, 1892)	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Neaetha tomkovichi Logunov, 2019	Guntur	Logunov, 2019
Phlegra prasanna Caleb & Mathai, 2015	Kadapa	Caleb *et al.*, 2015
Plexippus paykulli (Audouin, 1825)	Anantapur, Chittoor, Kadapa, Kurnool, Srikakulam, Visakhapatnam	Simon, 1885; Rao *et al.*, 1981; Majumder, 2005; Rao *et al.*, 2005; Ramasubba Reddy, 2014; Ramasubba Reddy, 2014; Palem *et al.*, 2016
Plexippus petersi (Karsch, 1878)	Chittoor, Kurnool	Ramasubba Reddy, 2014; iNaturalist, 2022
Saitis chaperi Simon, 1885	Anantapur	Simon, 1885

Family/Species	Distribution	References
Stenaelurillus arambagensis (Biswas & Biswas, 1992)	Prakasam	Caleb *et al.*, 2017
Stenaelurillus sarojinae Caleb & Mathai, 2014	Kadapa	Caleb & Mathai, 2014; Caleb *et al.*, 2015
Stenaelurillus tettu Logunov, 2020	Prakasam	Logunov, 2020
Stenaelurillus sp.	Kurnool	Ramasubba Reddy, 2014
Telamonia dimidiata (Simon, 1899)	Kurnool, Vigi5nagaram, West Godawari	Majumder, 2005; Ramasubba Reddy, 2014; iNaturalist, 2022
Thiania bhamoensis Thorell, 1887	Kurnool	Ramasubba Reddy, 2014
23. Scytodidae		
Scytodes thoracica (Latreille, 1802)	Kurnool	Ramasubba Reddy, 2014
24. Selenopidae		
Selenops radiatus Latreille, 1819	Anantapur	Simon, 1885
25. Sparassidae		
Heteropoda kandiana Pocock, 1899	Vigianagaram	Majumder, 2005
Heteropoda nilgirina Pocock, 1901	Kurnool, Prakasam	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Heteropoda sexpunctata Simon, 1885	Anantapur, Kurnool	Simon, 1885; Rao *et al.*, 2005; Ramasubba Reddy, 2014
Heteropoda venatoria (Linnaeus, 1767)	Anantapur, Kurnool, Visakhapatnam	Majumder, 2005; Ramasubba Reddy, 2014; iNaturalist, 2022
Olios sp.	Chittoor, Kadapa, Nellore	Palem *et al.*, 2016
Spariolenus tigris Simon, 1880	Kurnool, Prakasam	Rao *et al.*, 2005; Ramasubba Reddy, 2014
26. Stenochilidae		
Stenochilus hobsoni O. Pickard-Cambridge, 1871	Chittoor	Platnick & Shadab, 1974
27. Tetragnathidae		
Guizygiella indica (Tikader & Bal, 1980)	Kurnool	Rao *et al.*, 2005; Ramasubba Reddy, 2014
Leucauge celebesiana (Walckenaer, 1841)	Kurnool	Ramasubba Reddy, 2014
Leucauge decorata (Blackwall, 1864)	Chittoor, Kadapa, Kurnool, Nellore	Rao *et al.*, 2005; Ramasubba Reddy, 2014; Palem *et al.*, 2016
Leucauge fastigata (Simon, 1877)	Chittoor	iNaturalist, 2022

Family/Species	Distribution	References
Leucauge tessellata (Thorell, 1887)	Chittoor, Kadapa, Kurnool, Prakasam, Vigianagaram	Majumder, 2005; Rao *et al.*, 2005; Ramasubba Reddy, 2014; Palem *et al.*, 2016
Leucauge venusta (Walckenaer, 1841)	Kurnool	Ramasubba Reddy, 2014
Meta abdomenalis Patel & Reddy, 1993	Visakhapatnam	Patel & Reddy, 1993a
Tetragnatha ceylonica O. Pickard-Cambridge, 1869	Kurnool	Ramasubba Reddy, 2014
Tetragnatha keyserlingi Simon, 1890	Chittoor, Kadapa, Nellore	Palem *et al.*, 2016
Tetragnatha mandibulata Walckenaer, 1841	Chittoor, Kadapa, Kurnool, Nellore	Ramasubba Reddy, 2014; Palem *et al.*, 2016
Tetragnatha vermiformis Emerton, 1884	Kurnool	Ramasubba Reddy, 2014
28. Theraphosidae		
Chilobrachys fimbriatus Pocock, 1899	Guntur, Kurnool, Prakasam, Visakhapatnam	Rao *et al.*, 2005; Ramasubba Reddy, 2014; Ramasubba Reddy, 2016; iNaturalist, 2022
Chilobrachys hardwickei (Pocock, 1895)	Guntur, Kurnool, Prakasam	Rao *et al.*, 2005; Ramasubba Reddy, 2016
Chilobrachys khasiensis (Tikader, 1977)	Vigianagaram	Majumder, 2005
Chilobrachys sp.	Anantapur	Molur *et al.*, 2003
Heterophrictus blatteri (Gravely, 1935)	Visakhapatnam	Majumder, 2005
Neoheterophrictus madraspatanus (Gravely, 1935)	Chittoor	Gravely, 1935
Plesiophrictus meghalayaensis Tikader, 1977	Vigianagaram, Visakhapatnam	Majumder, 2005
Poecilotheria formosa Pocock, 1899	Guntur, Krishna, Prakasam	Rao *et al.*, 2006b; Molur *et al.*, 2008b; Ramasubba Reddy, 2016
Poecilotheria metallica Pocock, 1899	Anantapur, Guntur, Kurnool, Prakasam	Pocock, 1899, 1900; Molur *et al.*, 2003; Molur *et al.*, 2008b; Siliwal *et al.*, 2011; Ramasubba Reddy, 2016
Poecilotheria regalis Pocock, 1899	Anantapur, Chittoor, Guntur, Kurnool, Prakasam	Gravely, 1935; Molur *et al.*, 2003, 2004; Rao *et al.*, 2004, 2005; Molur *et al.*, 2008b; Siliwal *et al.*, 2011; Ramasubba Reddy, 2016

Family/Species	Distribution	References
Poecilotheria tigrinawesseli Smith, 2006	Visakhapatnam	Smith, 2006; Molur *et al.*, 2008b; Siliwal *et al.*, 2011
29. Theridiidae		
Argyrodes argentatus O. Pickard-Cambridge, 1880	Srikakulam	Javed *et al.*, 2010a
Argyrodes cyrtophorae Tikader, 1963	Kurnool	Ramasubba Reddy, 2014
Argyrodes dipali Tikader, 1963	Kurnool	Ramasubba Reddy, 2014
Argyrodes flavescens O. Pickard-Cambridge, 1880	Visakhapatnam	Javed *et al.*, 2010a
Coleosoma floridanum Banks, 1900	Srikakulam	Srinivasulu *et al.*, 2013
Cyllognatha surajbe Patel & Patel, 1972	Chittoor, Kadapa	Palem *et al.*, 2016
Nihonhimea tikaderi (Patel, 1973)	Chittoor, Kadapa	Palem *et al.*, 2016
Rhomphaea projiciens O. Pickard-Cambridge, 1896	Kurnool	Ramasubba Reddy, 2014
30. Thomisidae		
Camaricus bipunctatus Bastawade, 2002	Kurnool	Bastawade & Khandal, 2006
Camaricus sp.	Chittoor, Kadapa	Palem *et al.*, 2016
Misumena vatia (Clerck, 1757)	Kurnool	Ramasubba Reddy, 2014
Stiphropus duriusculus (Simon, 1885)	Anantapur	Simon, 1885
Thomisus godavariae Reddy & Patel, 1992	Guntur, Krishna, Nellore, Prakasam, Srikakulam	Reddy & Patel, 1992a
Thomisus katrajghatus Tikader, 1963	Srikakulam	Rao *et al.*, 1981
Thomisus krishnae Reddy & Patel, 1992	Guntur, Krishna, Nellore, Prakasam	Reddy & Patel, 1992a
Thomisus lobosus Tikader, 1965	Kurnool	Ramasubba Reddy, 2014
Thomisus pugilis Stoliczka, 1869	Kurnool	Ramasubba Reddy, 2014
Thomisus spectabilis Doleschall, 1859	Kurnool	Ramasubba Reddy, 2014
Thomisus sp.	Chittoor, Kadapa, Srikakulam	Rao *et al.*, 1981; Palem *et al.*, 2016

Family/Species	Distribution	References
Tmarus srisailamensis Rao, Bastawade, Javed & Krishna, 2006	Kurnool	Rao *et al.*, 2006b
31. Titanoecidae		
Pandava andhraca (Patel & Reddy, 1990)	Chittoor, East Godavari, Guntur, Krishna, Nellore, Prakasam, Srikakulam, Vigianagaram, Visakhapatnam, West Godavari	Patel & Reddy, 1990b
32. Uloboridae		
Philoponella feroka (Bradoo, 1979)	Chittoor	Babu *et al.*, 2022
Uloborus danolius Tikader, 1969	Chittoor, Kadapa	Palem *et al.*, 2016
Uloborus sp.	Chittoor, Kadapa	Palem *et al.*, 2016
33. Zodariidae		
Laminion arakuense (Patel & Reddy, 1989)	Visakhapatnam	Patel & Reddy, 1989
Laminion birenifer (Gravely, 1921)	Guntur, Visakhapatnam, West Godavari	Patel & Reddy, 1989
Laminion gujaratense Tikader & Patel, 1975)	Nellore, Visakhapatnam	Patel & Reddy, 1989
Mallinella indica (Tikader & Patel, 1975)	East Godavari	Patel & Reddy, 1989
Storenomorpha raghavai (Patel & Reddy, 1991)	Visakhapatnam	Patel & Reddy, 1991a
Suffasia gujaratensis (Tikader & Patel, 1975)	Nellore, Visakhapatnam	Patel & Reddy, 1989
Tropizodium kovvurense (Reddy & Patel, 1993)	West Godavari	Reddy & Patel, 1992e; Sankaran *et al.*, 2019

Four species of tarantulas (Theraphosidae) recorded from Andhra Pradesh are put in Red List of IUCN (Molur *et al.*, 2008b). One species, *Poecilotheria metallica* Pocock, 1899 is declared *Critically Endangered* (Molur *et al.*, 2008a), *Poecilotheria formosa* Pocock, 1899 is declared *Endangered* (Molur *et al.*, 2008c), *Poecilotheria regalis* Pocock, 1899 is assessed as *Least Concern* (Molur *et al.*, 2008d), and *Poecilotheria tigrinawesseli* Smith, 2006 is assessed as *Data Deficient* (Siliwal *et al.*, 2008).

The maximum number of species of spiders were recorded from Kurnool (80 species) followed by Chittoor (60 species), Kadapa (44 species), Visakhapattanam (37 species), Prakasham (33 species), Anantapur and Nellore (29 species each), Guntur (19 species), Vizianagaram (16 species), Srikakulam (15 species), and less number of species in other districts (Fig. 1). Most of the national parks and wildlife sanctuaries, forest areas, agricultural fields, human dwellings etc. of Andhra Pradesh still await intensive and extensive survey programmes to record a near complete spider fauna. Total 10 species

recorded from different districts of Andhra Pradesh were identified only upto generic level (Table 1). Also, 15 species seem to be misidentified as these species are not recorded in India (World Spider Catalog, 2022; Caleb & Sankaran, 2022) (Table 2) and are excluded from this checklist.

Table 2. Doubtful and erroneous records of spider species from Kurnool district, Andhra Pradesh.

Family	Species	References
Atracidae	*Atrax robustus* O. Pickard-Cambridge, 1877	Ramasubba Reddy, 2016
Araneidae	*Aculepeira ceropegia* (Walckenaer, 1802)	
Corinnidae	*Merenius alberti* Lessert, 1923	
	Nyssus albopunctatus (Hogg, 1896)	
Gnaphosidae	*Callilepis pluto* Banks, 1896	
	Drassyllus praeficus (L. Koch, 1866)	
	Herpyllus propinquus (Keyserling, 1887)	
	Zelotes latreillei (Simon, 1878)	
Lycosidae	*Hogna carolinensis* (Walckenaer, 1805)	
Oxyopidae	*Oxyopes elegans* L. Koch, 1878	
	Oxyopes scalaris Hentz, 1845	
Pisauridae	*Dolomedes tenebrosus* Hentz, 1844	
Salticidae	*Menemerus semilimbatus* (Hahn, 1829)	
	Pelegrina proterva (Walckenaer, 1837)	
Zodariidae	*Mallinella shimojanai* (Ono & Tanikawa, 1990)	

Ramasubba Reddy, 2014

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Zodarion lutipes (O. Pickard-Cambridge, 1872) (Araneae: Zodariidae) a new record from Iraq

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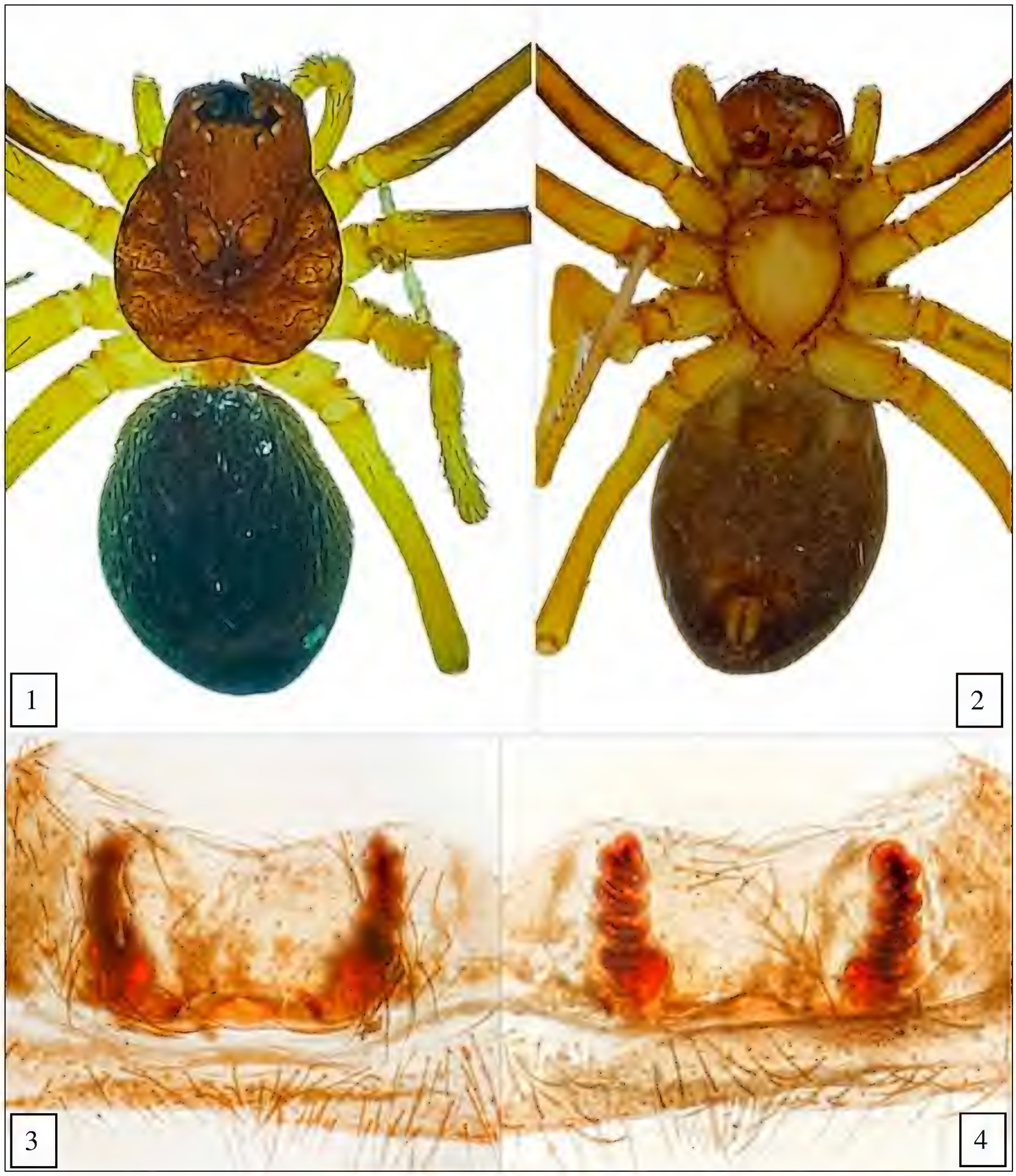
Abstract

The female of *Zodarion lutipes* (O. Pickard-Cambridge, 1872) is reported for the first time from Iraq, based on new material collected from Dhi Qar province, southern Iraq. A description, digital photos, and a distribution map are presented.

Keywords: Araneae, ant spiders, distribution, Iraq.

Introduction

Zodariidae Thorell, 1881 is one of the largest families within Araneomorphae, represented by 1215 species belonging to 87 genera (World Spider Catalog, 2022). Members of this family are characterized by a medium-size, absence of serrula, tarsal claws with lateral teeth, long anterior spinnerets, and occur mainly in tropical and subtropical regions (Jocqué, 1991). The genus *Zodarion* Walckenaer, 1826 is the second largest genus after *Mallinella* Strand, 1906 of this family, represented by 174 described species worldwide, and there are 60 species of *Zodarion* ant spiders known from Asia, 31 of them are reported in the neighbouring country of Iraq, Turkey (World Spider Catalog, 2022). However, family Zodariidae in Iraq is still unstudied, only the species *Zodarion sungar* (Jocqué, 1991) is known from this country so far, which has been described from Sinjar District in Mosul province, northern Iraq. Despite the passage of thirty years, no specimens of this family were rediscovered in Iraq. During the collection of new material from Dhi Qar province southern Iraq, specimens belonging to *Zodarion* were found and identified as *Z. lutipes* (O. Pickard-Cambridge, 1872). The aim of this paper is to report this species for the first time from Iraq.



Figs. 1-4. *Zodarion lutipes* (O. Pickard-Cambridge, 1872) female. 1-2. Habitus. 1. dorsal view. 2. ventral view. 3-4. Epigyne. 3. dorsal view. 4. ventral view.

Material and Methods

The material was collected from a rural region planted in Qalat Sukar District, Dhi Qar Province in southern Iraq (Fig. 1). The specimens were examined and photographed under ethanol by using a Nikon camera on an ED4 stereomicroscope. The epigyne was purified in KOH water solution until soft tissues were dissolved. Spiders are preserved in 70% denatured ethanol and deposited in Invertebrate Lab in College of Basic Education, University of Sumer, Dhi Qar, Iraq. Leg measurements are provided as total length (femur, patella, tibia, metatarsus, tarsus). All measurements are in mm.

Taxonomy

Family **Zodariidae** Thorell, 1881
Genus ***Zodarion*** Walckenaer, 1826

Zodarion lutipes (O. Pickard-Cambridge, 1872) (Figs. 1-4)
For taxonomic references see the World Spider Catalog (2022).
Specimens examined. Southern **Iraq**, Dhi Qar Province, Qalat Sukar district, Aljdoua village annual agricultural land, under dry mud piles, 31.85732°N, 46.08153°E, 12 m a.s.l. (Fig. 5), 2 July 2021, 1♀ and 1♀ subadult, Leg. A.M. Al-Khazali.
Identification. According to Levy (1992) and Bosmans (2009).
Description of female. General appearance as in Figs. (1-2). Measurements: Body length 5.04; prosoma 1.53 long, 1.12 wide; opisthosoma 2.62 long, 1.51 wide. Leg measurements: I 5.65 (1.78, 0.78, 1.12, 1.28, 0.69), II 4.84 (1.45, 0.72, 1.10, 1.08, 0.49), III 5.07 (1.29, 0.77, 1.02, 1.12, 0.87), IV 5.88 (1.62, 0.92, 1.31, 1.18, 0.85). Carapace reddish brown, anterior head margin is roughly square (Fig.1); ocular area of anterior median eyes is dark; sternum, coxae, maxillae, chelicerae and legs uniformly yellowish. Opisthosoma oval, dorsally dark brown, ventrally grey brown, covered with fine brown setae, spinnerets light brown. Epigyne: as in Figs. (3-4), for a re-description see Levy (1992) and Bosmans (2009).

Distribution. The species was previously known from five countries in the Middle East: Jordan, Lebanon, Iran, Cyprus, and Palestine/Israel (World Spider Catalog, 2022). The current record from Iraq is an increase in the distribution of this species within the West Asian countries (Fig. 5).

Fig. 5. Map showing the global distribution of *Zodarion lutipes* (O. Pickard-Cambridge, 1872). circle = current study, squares = previous records.

Comments

According to World Spider Catalog (2022), there are 31 species of the genus *Zodarion* recorded in Turkey, so according to the location of Iraq neighbouring this country, it is expected that the number of these species in Iraq will increase with the increase in the survey of areas by local researchers, especially the northern areas close to the Iraqi-Turkish border.

Acknowledgment

My gratitude to Alireza Zamani (University of Turku, Finland) for providing scientific advice on the identification of the species.

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New locality data of *Stegodyphus lineatus* (Latreille, 1817) (Araneae: Eresidae) from Basrah province south of Iraq

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Abstract

Stegodyphus lineatus (Latreille, 1817) is a member of family Eresidae which is commonly known as velvet spiders. This species was recorded from neighbouring countries as well as unknown locality from Iraq. In current study, definite localities of the species are recorded from south of Iraq. The images of adult female and its epigynum are presented.

Keywords: Araneae, Eresidae, *Stegodyphus*, locality, Basrah, Iraq.

Introduction

Eresidae, commonly known as velvet spiders, is a relatively small family contained only nine genera, 97 species, and 5 subspecies (World Spider Catalog, 2022).

Stegodyphus is a genus of velvet spiders that was first established by Simon in 1873. Most of its twenty species are distributed in Africa and Asia. It is represented by only one species in southern Europe and one species in Brazil (World Spider Catalog, 2022).

Stegodyphus lineatus (Latreille, 1817) has been recorded from neighbouring countries of Iraq: Turkey (Kraus & Kraus, 1989; Miller *et al.*, 2012), Syria (Kraus & Kraus, 1989), Jordan (El-Hennawy, 1987; Kraus & Kraus, 1989), and Iran (Kraus & Kraus, 1989; Zamani & Marusik, 2018). It was recorded from an unknown locality from Iraq by Kraus & Kraus (1989): "Mesopotamia (1♀ MNHN AR 932)" [Only 1 female specimen in Paris natural history museum] (Zamani & El-Hennawy, 2016; Fomichev *et al.*, 2018).

In the current study, the females of *Stegodyphus lineatus* (Latreille, 1817) were collected from three sites of Basrah province desert south of Iraq.

The aim of this study is to present definite localities of this species with images of the adult and its epigynum.

Fig. 1. Collecting sites (red circles) of *Stegodyphus lineatus*, near Basrah, Iraq.

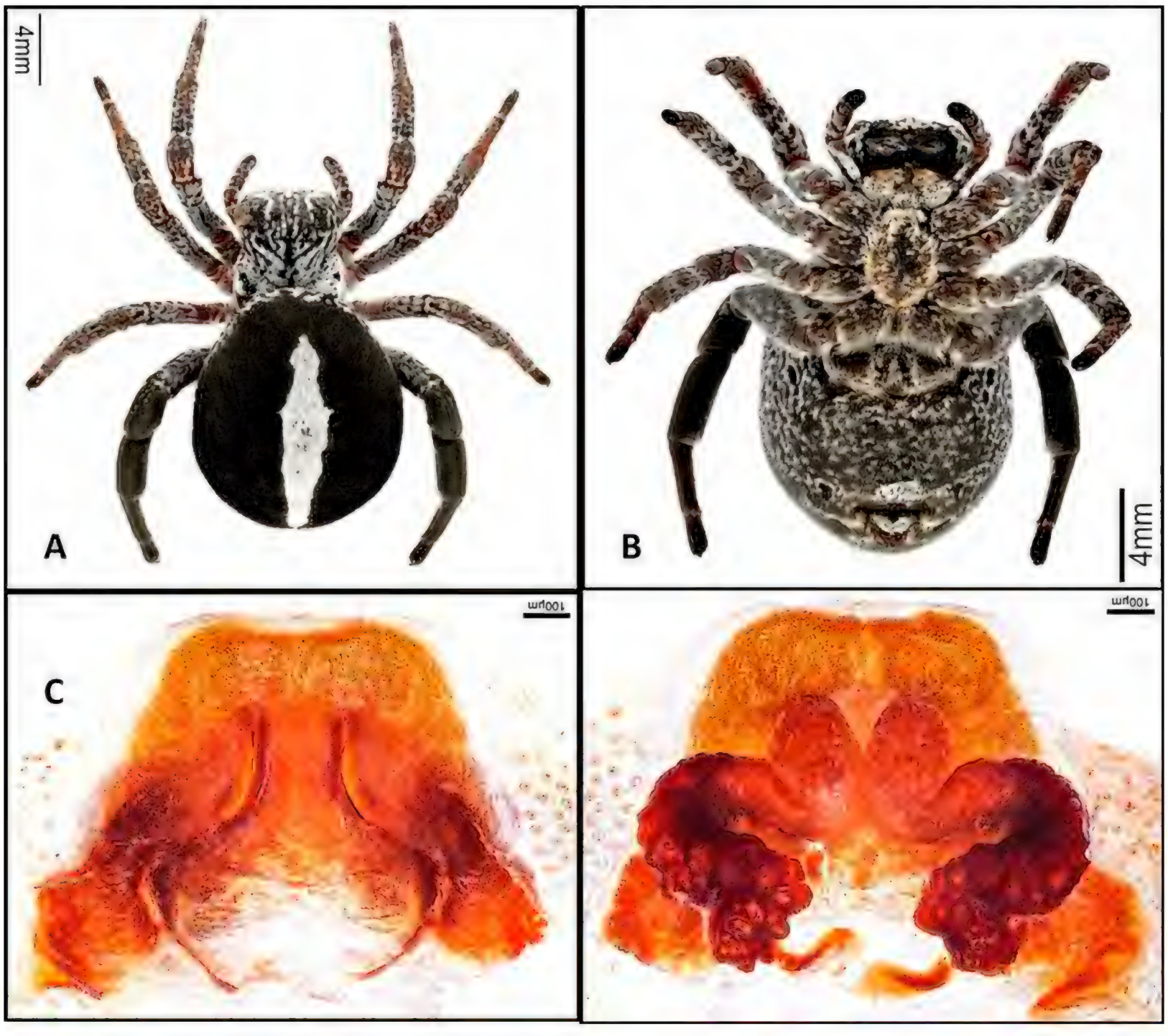

Fig. 2. *Stegodyphus lineatus* (Latreille, 1817) female. A-B. Habitus. A. dorsal view. B. ventral view. C. Epigynum, ventral view. D. Vulvae, dorsal view.

Material and Methods

In the current study, 12 females of *Stegodyphus lineatus* were collected from three sites of Basrah province desert: 1- Artawi (30º34'48.108"N, 47º0'44.97"E), 2- Hammar Mushrif (30º28'58.6632"N, 47º37'11.442"E), 3- AL-Touba (30º26'18.4956"N, 47º24'15. 4404"E), (Fig. 1), during the period from 1 September 2021 to 1 April 2022.

Hand collecting method was taken on collecting the specimens from *Astragalus* plants, where the webs of *Stegodyphus lineatus* were built inside them (Fig. 3).

Spiders were preserved in ethyl alcohol 80%, examined and photographed by Leica microscope in Entomology laboratory of Science college, Basrah university.

The specimens were identified according to El-Hennawy (2009).

Results

Material examined: 5♀♀, Artawi; 4♀♀, Al-Touba; 3♀♀, Hammar Mushrif; 1 September 2021 to 1 April 2022; Leg. Shurooq A. Najim.
Total length: 13.2-15.1 mm, Fig. (2A) dorsal view, Fig. (2B) ventral view.
Cephalothorax length: 4.4-5.1 mm. Abdomen length: 8.9-10 mm.
Female genitalia: Figs. 2C-D) 0.90-0.95 mm.

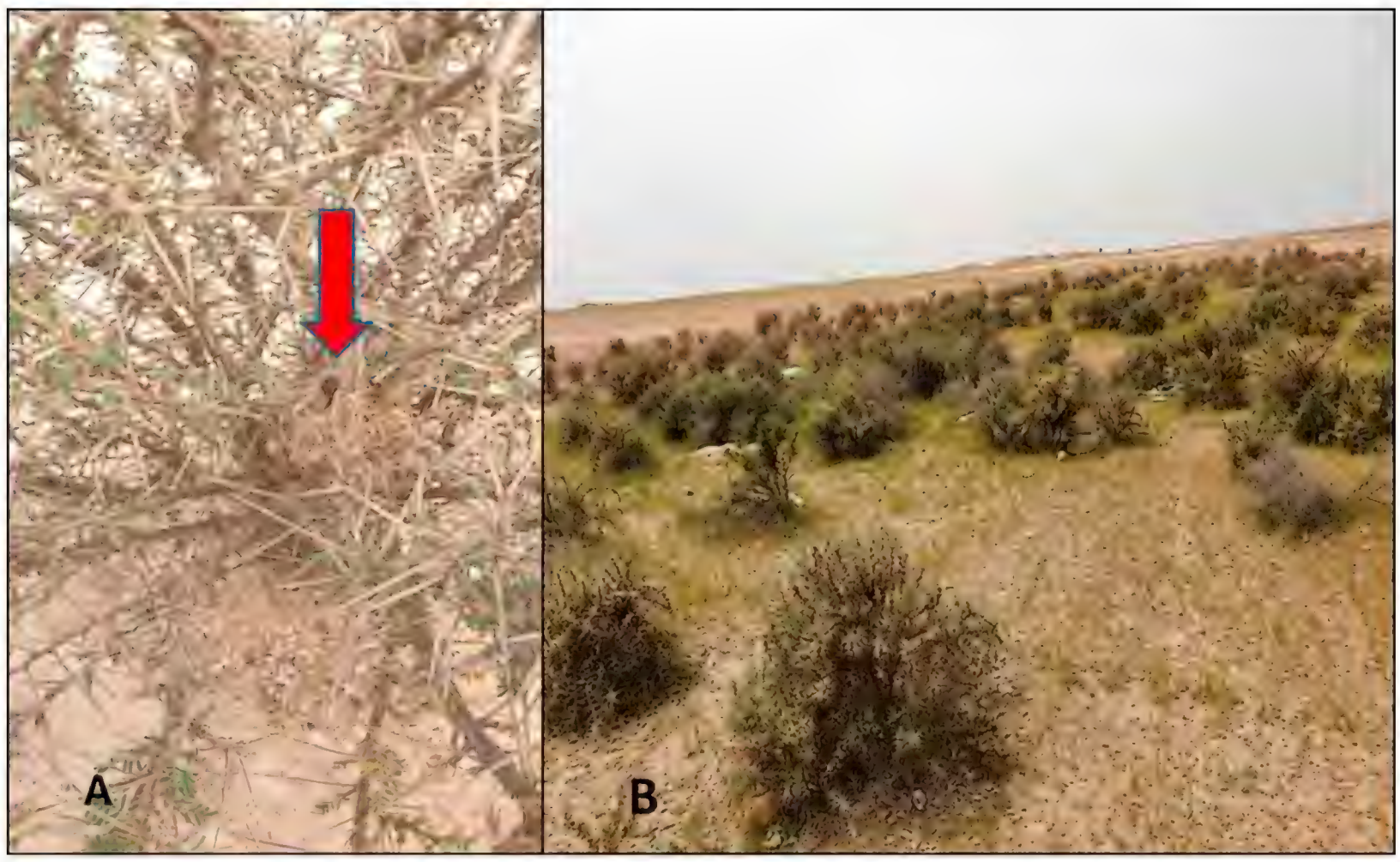

Fig. 3. A. *Astragalus* plant and the web of *Stegodyphus lineatus* inside it. B. Habitat of *Stegodyphus lineatus* at Basrah desert south of Iraq.

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Genus *Zelotes* Gistel, 1848 (Araneae: Gnaphosidae), a new record from Iraq

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Abstract

The genus *Zelotes* Gistel, 1848 is recorded in Iraq for the first time. Females and males of *Zelotes subterraneus* (C.L. Koch, 1833) were collected from an agricultural area in Thi Qar province, southern Iraq. Illustrations of epigynum and palp of the species and a map of the specimens collecting location are provided.

Keywords: Araneae, *Zelotes subterraneus*, new record, Ur, Iraq.

Introduction

Family Gnaphosidae currently includes 2414 species with 144 genera, and there are 397 species belonging to the genus *Zelotes* Gistel, 1848 (World Spider Catalog, 2022).

In Iraq, only 6 species of the family Gnaphosidae are recorded: *Berlandina mesopotamica* Al-Khazali, 2020, *Gnaphosa dolosa* Herman, 1879, *Nomisia conigera* (Spassky, 1941), *Pterotricha arzhantsevi* Fomichev, Marusik & Koponen, 2018, *P. esyunini* Zamani, 2018, and *P. kovblyuki* Zamani & Marusik, 2018 (Fomichev *et al.* 2018; Al-Khazali & Hussein, 2019; Al-Khazali, 2020; Al-Yacoub *et al.* 2021a,b).

Zelotes subterraneus (C.L. Koch, 1833) has been recorded in Turkey (Asian part), the neighbouring country of Iraq (Danışman *et al.*, 2022).

The aim of the current study is to provide new data on the fauna of spiders in Iraq, which is still few.

Material and Methods

The specimens were taken from Thi Qar Province, southern Iraq (Fig. 1), from an agricultural area on the banks of the Euphrates River, southeast of the city of Nasiriyah (Fig. 2). Specimens were preserved in 70% ethanol, photographed with a Nikon Z50 camera on a Krüss stereomicroscope, then digital images were prepared using image stacking software (Zerene stacker). The measurements were given for the segments of the legs as follows: total length (femur, patella, tibia, metatarsus, tarsus). All measurements are in millimetres (mm).

Fig. 1. Map of collecting location of *Zelotes subterraneus* (red circle): Thi Qar Province, southeast of Al-Nasiriyah city, Ur district, Iraq.

Fig. 2. Habitat of *Zelotes subterraneus*, Ur district.

Results

Family **Gnaphosidae** Banks, 1892
Genus ***Zelotes*** Gistel, 1848

Zelotes subterraneus (C.L. Koch, 1833) (Figs. 3-5).
Z. subterraneus Murphy & Platnick, 1986: 98, f. 5-8 (♂♀).
Z. subterraneus Ponomarev & Shmatko, 2019: 10, f. 49-64 (♂♀).
For full taxonomic references, see World Spider Catalog (2022).

Material Examined. 1♂ 6♀♀ and 20 subadults, Ur district, Thi Qar Province, south of Iraq, 31°01'42.5"N 46°18'07.1"E, 10-20 April 2022.
Diagnosis. Epigynum in female (Fig. 4), there is a clear loop in the median ducts of epigynum on the ventral view. Palp in male (Fig. 5), end of the embolus is smoothly curved and tapered towards the tip, giving it a characteristic sickle-shaped appearance.

Description. Female: Habitus as in Fig. (3). Total length 8.5. Prosoma 3.5 length, 2.5 width. Opisthosoma 5.0 length. Prosoma, labium, sternum, and maxillae are dark brown. Eyes are arranged in two rows, silvery in colour with blackening in the anterior middle eyes, the posterior middle eyes are oval. Opisthosoma grey with bristles and three pairs of light spots in the middle. Legs are dark brown with measurements as follows: I 7.4 (2.0, 1.1, 1.9, 1.4, 1.0), II 6.9 (2.0, 1.2, 1.5, 1.2, 1.0), III 6.6 (2.0, 1.0, 1.3, 1.4, 0.9), IV 10.0 (2.5, 1.5, 2.0, 2.9, 1.1). Male is similar to the female with some differences in the measurements, Total length 6.5. Prosoma 2.5 length, 1.5 width. Opisthosoma 4.0 length. Legs: I 7.3 (2.2, 1.0, 1.9, 1.2, 1.0), II 6.8 (2.2, 1.0, 1.5, 1.2, 0.9), III 6.2 (2.0, 0.9, 1.2, 1.2, 0.9), IV 8.7 (2.5, 1.2, 2.0, 2.0, 1.0).

Fig. 3. *Zelotes subterraneus* (C.L. Koch, 1833) ♀. Habitus, dorsal view.

Discussion

Z. subterraneus is widespread in Europe, Turkey, the Caucasus, Russia from the European part to the Far East, Central Asia and China (World Spider Catalog, 2022). Platnick & Shadab (1983) classified the species as European. Kovblyuk (2006) indicated that all *Z. subterraneus* results should be validated in the Asian part of the Palaearctic region. In the current study, it is recorded for the first time in Iraq.

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Figs. 4-5. *Zelotes subterraneus* (C.L. Koch, 1833). 4. ♀, Epigynum, ventral view. 5. ♂, Palp, ventral view.

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Community organization of social spider *Stegodyphus sarasinorum* Karsch, 1892 in Kerala

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Abstract

Social spiders are widely distributed geographically and the social spider found in India shows different behavioural attributes. The present study identified the presence of Indian cooperative spider *Stegodyphus sarasinorum* Karsch, 1892 colonies in different districts of Kerala. Beyond the conventional method of taxonomic identification, the molecular method was used to identify the organism. Along with the morphometric analysis of *S. sarasinorum*, sexual size dimorphism was also investigated. The study shows the distribution of colonies in four districts of Kerala (1 m to 80 m above msl) and the molecular sequence of *S. sarasinorum* shows with the other social spider *S. mimosarum* found in Africa and Madagascar and solitary spider *S. dufouri* distributed in South and North Africa. The sexual size dimorphism index confirmed the dimorphism in this social spider.

Keywords: Social spider, Kerala, Distribution, Sexual dimorphism index, *Stegodyphus*.

Introduction

Most genera under the family Eresidae are found predominantly in arid areas of Africa and Eurasia although some species are found in rainforests of the Afrotropical and Neotropical regions (World Spider Catalog, 2022). The members of genus *Stegodyphus* typically build silken nests in vegetation while other eresids typically live in silk tubes under objects (e.g., bark, stones) or underground (Simon, 1873). Kraus & Kraus (1989) and Johannesen *et al.* (2007) found that *Stegodyphus* exhibit unreliable degrees of solitary

and subsocial behaviour and at least three species have independently evolved quasi-social behaviour.

Stegodyphus sarasinorum Karsch, 1892 is an Indian cooperative spider found in arid and semi-arid habitats throughout India, Sri Lanka, Nepal, Afghanistan, and Myanmar (Kraus & Kraus, 1989; World Spider Catalog, 2022). The ecology and natural history of *S. sarasinorum* have been investigated by Jambunathan (1905), Bradoo (1972, 1975, 1980), Jackson & Joseph (1973), Kraus & Kraus (1989), and Chakravarthy *et al.*, 2015. In earlier times, Jambunathan (1905) and Subrahmanyam (1953) reported information on the habits and life history of *S. sarasinorum* from the Madras state. In 1972, Bradoo found the newly established nest of *S. sarasinorum* on telephone lines of several localities of several Kottayam and Thrissur districts of Kerala and some paddy fields of Kerala; and others reported this social spider from Bengaluru, Karnataka, India (Smith & Engel 1994; Chakravarthy *et al.*, 2015), Kuppam, Andhra Pradesh (Beleyur *et al.*, 2015), Villukuri, Thirunelveli and Nilgiri Biosphere Reserve, Tamil Nadu (Beleyur *et al.*, 2015; Parthasarathy & Somanathan, 2018; Pathmavathy & Ebanasar, 2018).

The degree of size difference in male and female spiders has a great role in the life-history traits (Skow & Jakob, 2003; Bowden *et al.*, 2013). For the differentiation of sex in social spider, morphometric studies were used (Suthaharan, 1986). Prenter *et al.* (1999) explained the sexual dimorphism in spiders by providing evidence of increased fecundity selection in females. The difference between the morphs was explained by the morphometrical and developmental data. The reproductive isolation confirmed the occurrence of copulation of the individuals of the same morphs (Aisenberg & Costa, 2008). Sexual size dimorphism has a great role in the cannibalistic behaviour in spiders and it was positively correlated (Wilder & Rypstra, 2008). The body size of the spider determined the rate of web takeover and defence (Eichenberger *et al.*, 2009). And climate change affects the increased sexual size dimorphism in spiders with an increase in altitude (Høye & Hammel, 2010). The morphometric measurements of seven species of spiders from the south Indian region were analysed by Arunkumar & Jayaprakash (2014) and the morphometric measurements and sexual dimorphism of both males and females of the Red House spider of South Banglore, Karnataka was done by Jalajakshi & Vinutha (2014) and oxyopid spiders from Karnataka by Ramakrishnaiah *et al.* (2018).

In this study, the presence of the colonies of *S. sarasinorum* found in Kerala was identified. Beyond the conventional method of taxonomic identification, molecular method was used to identify the organism. By using the morphometric analysis of the Indian social spider *S. sarasinorum*, the sexual size dimorphism index was investigated.

Material and Methods

Presence of *S. sarasinorum* colonies in Kerala

During the study, the social spider *S. sarasinorum* colonies in various places of Kerala was identified using the visual searching method and mapped using the Geographic Information System (GIS 10.3).

Identification of *S. sarasinorum*

The collected spiders were identified using taxonomic keys (Karsch, 1892; Tikader, 1987) and molecular analysis was also conducted to identify the specimen and it was carried out at Regional Facility for DNA Fingerprinting (RFDF), Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram.

Sequence Analysis

The sequence quality was checked using Sequence Scanner Software v1 (Applied Biosystems). Sequence alignment and required editing of the obtained sequences were carried out using Geneious Pro v5.1 (Drummond *et al.*, 2010). Species identification was carried out using the BLAST method. And the sequence deposited in NCBI GenBank.

To find out the probable evolutionary position of the *Stegodyphus sarasinorum*, which is genetically identified in this study (MZ364328.1), the authors have retrieved the following sequence from the NCBI: DQ973158.1, DQ973157.1, DQ973155.1, KY020277.1, DQ973162.1, KU232702.1, KU232698.1, FJ949017.1, and MT472136.1. The evolutionary position of other social spiders among the *Stegodyphus* sp. has also been analysed in this investigation. The phylogenetic analysis of the COXI gene of the isolated specimen clearly confirmed the morphological identification since the isolated nucleotide sequence has exhibited close resemblance towards the other above mentioned retrieved sequences of NCBI that are representing the *S. sarasinorum*.

Morphometry of *S. sarasinorum*

Site of collecting

The study area comprises:

1. Thrissur (Christ College campus, Irinjalakuda, Kerala, 10°21'30.6"N, 76°12'49.96"E): The spiders have been distributed in the plants including trees (*Artocarpus heterophyllus*), shrubs (*Eugenia uniflora*), grass (*Pennisetum polystachion*).
2. Kollam (Monroe thuruth, Kollam, Kerala, 8°59'4.2"N, 76°36'33.51"E). The spiders were distributed in the mangrove plants *Acanthus ilicifolius*.

Sampling method and morphometric measurements

The spiders were collected by using aerial hand collecting from the selected locations of Kerala. The males and females (three spiders each) were collected from each site and collected specimens were brought to the laboratory. The specimens were preserved in 70% alcohol.

Morphometric measurements were carried out using Leica M205C stereo-microscope. All variables were measured in cm and the data were analyzed in Microsoft Excel for Mean ± Standard Error. The digital images were taken using Leica DMC 4500 digital camera attached to Leica M205C stereomicroscope, with a software package Leica Application Suite (LAS). The studied specimens were deposited in the reference collection at the Centre for Animal Taxonomy and Ecology (CATE), Department of Zoology, Christ College Irinjalakuda, Kerala, India.

Sexual size dimorphism was calculated using the sexual dimorphism index (SDI) of Lovich & Gibbons (1992), SDI = size of largest sex/size of smallest sex.

This index is arbitrarily assigned a negative sign if males are larger and a positive sign if females are larger.

Results

The colonies of *S. sarasinorum* (Fig. 1A) were found in four different districts of Kerala including Palakkad, Kozhikode, Thrissur, and Kollam (Fig. 1B & Table 1). The phylogenetic perspectives of the social spiders in genus *Stegodyphus* have also been verified in this investigation. The position of the isolated specimen (*S. sarasinorum*) in the social spider community, especially in genus *Stegodyphus* has been validated in Fig. (2). From the phylogenetic analysis, the authors have analyzed the fact that the isolated

specimen (MZ364328.1: *Stegodyphus sarasinorum*) has shared genetic similarities with other previously reported social spiders such as *Stegodyphus mimosarum* (FJ949017.1) and *Stegodyphus dufouri* (MT472136.1). The sexual size dimorphism index confirmed that males are larger than the female spiders in *S. sarasinorum* species (Fig. 3 & Tables 2-4).

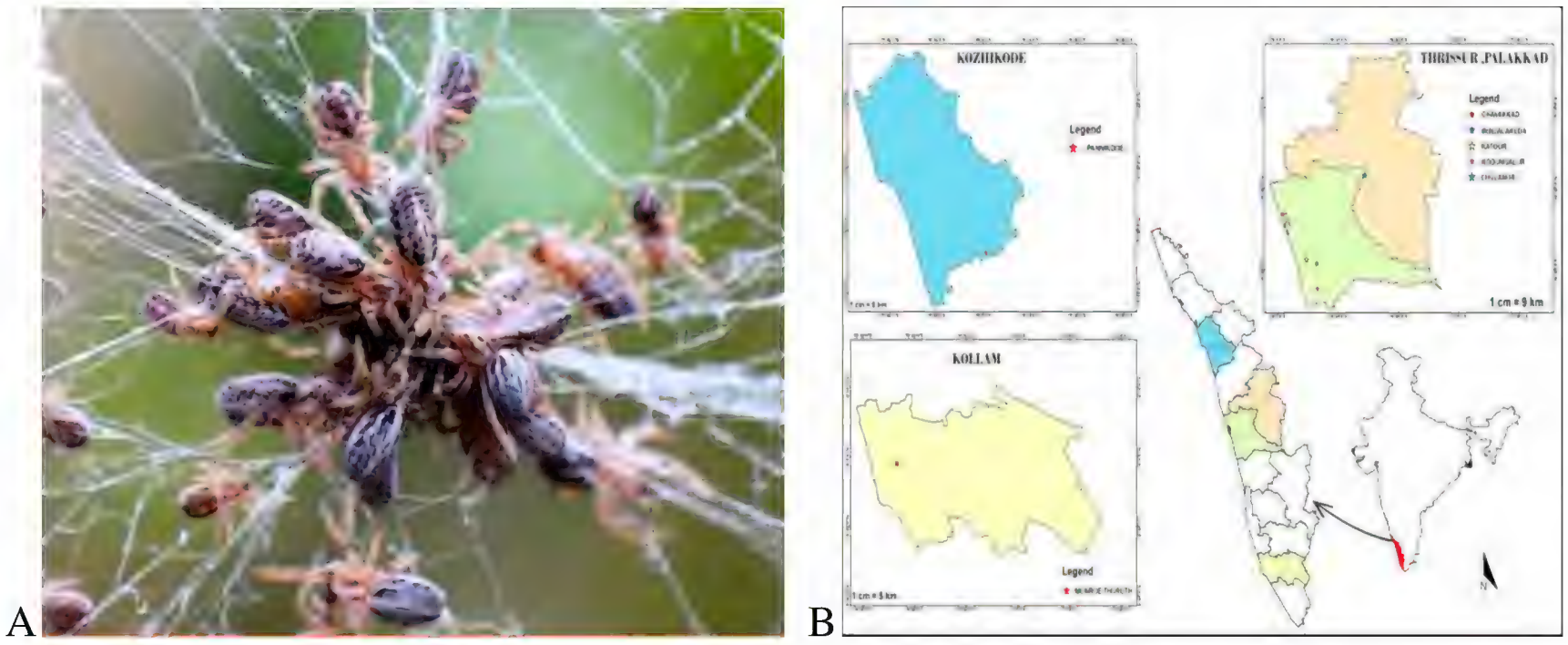

Fig. 1. **A.** Communal feeding of *Stegodyphus sarasinorum*. B. Map showing the presence of social spider *S. sarasinorum* colonies in different locations of Kerala.

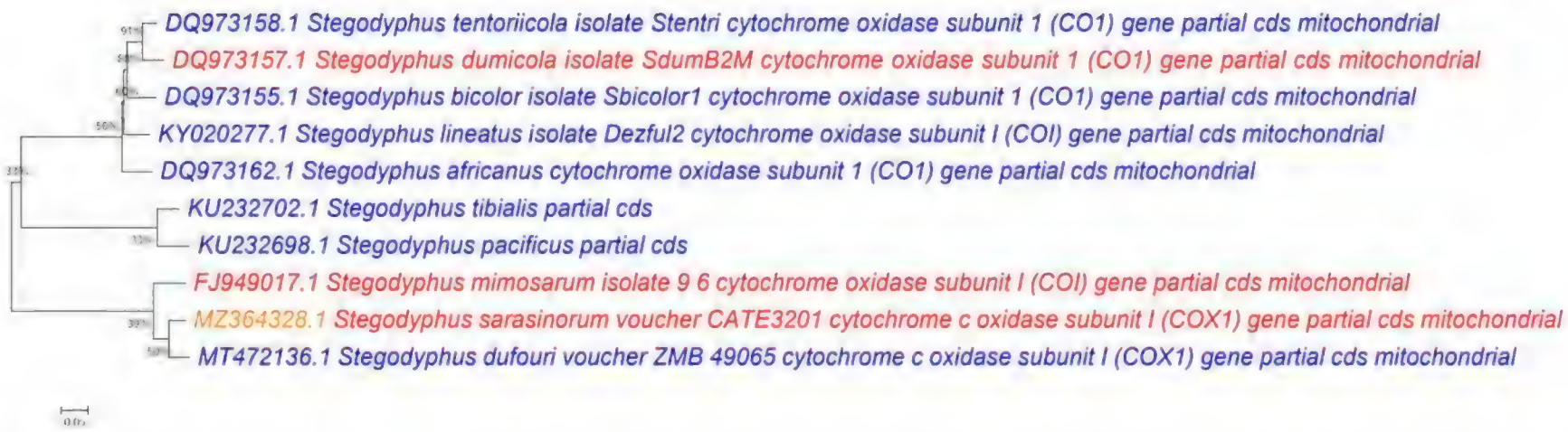
DQ973158.1 Stegodyphus tentoriicola isolate Stentri cytochrome oxidase subunit 1 (CO1) gene partial cds mitochondrial
DQ973157.1 Stegodyphus dumicola isolate SdumB2M cytochrome oxidase subunit 1 (CO1) gene partial cds mitochondrial
DQ973155.1 Stegodyphus bicolor isolate Sbicolor1 cytochrome oxidase subunit 1 (CO1) gene partial cds mitochondrial
KY020277.1 Stegodyphus lineatus isolate Dezful2 cytochrome oxidase subunit I (COI) gene partial cds mitochondrial
DQ973162.1 Stegodyphus africanus cytochrome oxidase subunit 1 (CO1) gene partial cds mitochondrial
KU232702.1 Stegodyphus tibialis partial cds
KU232698.1 Stegodyphus pacificus partial cds
FJ949017.1 Stegodyphus mimosarum isolate 9 6 cytochrome oxidase subunit I (COI) gene partial cds mitochondrial
MZ364328.1 Stegodyphus sarasinorum voucher CATE3201 cytochrome c oxidase subunit I (COX1) gene partial cds mitochondrial
MT472136.1 Stegodyphus dufouri voucher ZMB 49065 cytochrome c oxidase subunit I (COX1) gene partial cds mitochondrial

Fig. 2. The phylogenetic tree showing the evolutionary position of the isolated specimen (MZ364328.1: *S. sarasinorum,* accession number highlighted in orange colour) and other social spiders (accession number highlighted in red colour) among the *Stegodyphus* sp.

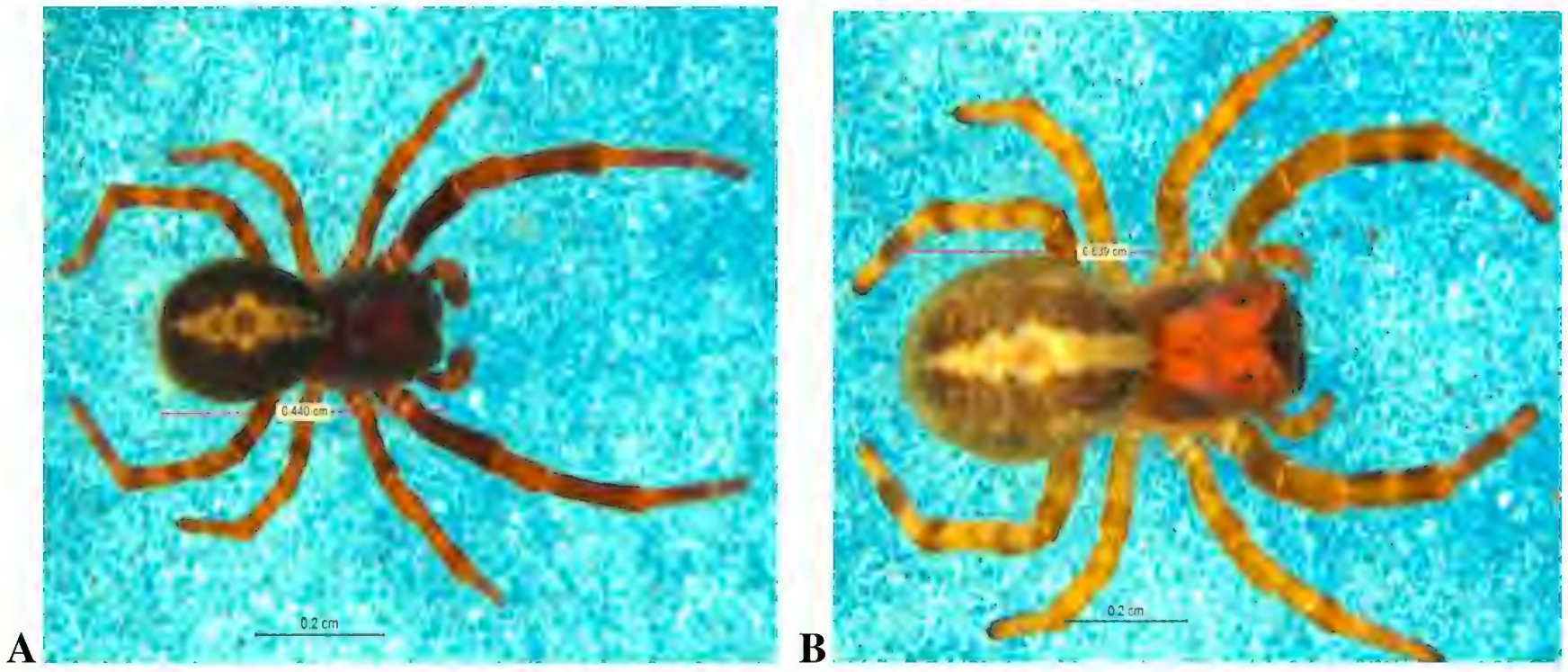

Fig. 3. *Stegodyphus sarasinorum* Karsch, 1892. **A**. Male. B. Female.

Table 1. Details of the specimens collected from different geographical locations in Kerala.

SL. No.	Location (District)	Latitude & Longitude	Altitude (m a.m.s.l.)	Habitat
1	Chavakkad (Thrissur)	10°33'44.82"N 76°1'33.24"E	2	Shrub (*Hibiscus rosa-sinensis*); Trees (*Tamarindus indica*, *Artocarpus heterophyllus*)
2	Irinjalakuda (Thrissur)	10°21'30.60"N 76°12'49.96"E	18	Grass (*Pennisetum polystachion*); Shrub (*Eugenia uniflora*); Tree (*Artocarpus heterophyllus*)
3	Kattoor (Thrissur)	10°22'30.86"N 76°9'29.05"E	4	Tree (*Mangifera indica*)
4	Kodungallur (Thrissur)	10°15'21.56"N 76°13'03.11"E 10°14'22.52"N 76°12'44.32"E	1 1	Mangrove (*Acanthus ilicifolius*); Trees (*Tamarindus indica*, *Artocarpus heterophyllus*)
5	Chulannur (Palakkad)	10°43'20.03"N 76°28'48.18"E	80	Tree (*Cleistanthus collinus*)
6	Pannikode (Kozhikode)	11°16'27.56"N 76°0'32.40"E	23	Tree (*Gliricidia sepium*)
7	Monroe Thuruth (Kollam)	8°59'4.20"N 76°36'33.51"E	2	Mangrove (*Acanthus ilicifolius*); Tree (*Acacia auriculiformis*)

Table 2. Morphometric measurements (in cm) of cephalothorax, abdomen and total length of the *S. sarasinorum*.

District	Sex	Cephalothorax (Mean ± SE)		Abdomen (Mean ± SE)		Total Length
		Length	Width	Length	Width	
Thrissur	♂	0.209 ± 0.011	0.157 ± 0.005	0.274 ± 0.009	0.186 ± 0.008	0.455 ± 0.012
	♀	0.309 ± 0.001	0.206 ± 0.012	0.478 ± 0.040	0.318 ± 0.020	0.726 ± 0.038
Kollam	♂	0.206 ± 0.008	0.14 ± 0.014	0.267 ± 0.016	0.177 ± 0.005	0.453 ± 0.008
	♀	0.253 ± 0.008	0.192 ± 0.006	0.391 ± 0.013	0.275 ± 0.013	0.613± 0.011

Discussion

Stegodyphus sarasinorum is found in arid and semi-arid habitats throughout India. In 1972, Bradoo found the newly established nest of the *S. sarasinorum* on telephone lines of several localities of several Kottayam and Thrissur districts of Kerala and some paddy fields of Kerala. The documentation of this spider fauna from Kerala is insufficient. So in this study, the presence of the Indian social spider was mapped. This spider is distributed in various districts of Kerala including Palakkad, Kozhikode, Thrissur, and Kollam. They are mainly found in the area near the ground, rocky habitat and riparian habitat. The distribution ranges from Kodungallur (1 m above m.s.l.) and Chavakkad (Thrissur) and Monroe thuruth (Kollam) (2 m a.m.s.l.) to Chulannur (Palakkad, 80 m a.m.s.l.). Pathmavathy & Ebnasar (2018) reported that in Tamil Nadu, *S. sarasinorum* was absent in altitude above 1441 m above sea level while in the lower altitude its distribution was more (925 m a.m.s.l.). Because of the intolerance towards the lower temperature, *S. sarasinorum* colonies distribution decreases with an increase in altitude.

Table 3. Morphometric measurements (in cm) of the legs of *S. sarasinorum*.

			Leg Segments (Mean ± SE) (cm)							
District	Sex	Leg	Coxa	Trochanter	Femur	Patella	Tibia	Metatarsus	Tarsus	Total Length
Thrissur	♂	1	0.064 ± 0.0005	0.029 ± 0.001	0.119 ± 0.006	0.044 ± 0.0014	0.140 ± 0.011	0.103 ± 0.011	0.063 ± 0.005	0.564 ± 0.022
		2	0.048 ± 0.002	0.023 ± 0.003	0.089 ± 0.006	0.033 ± 0.001	0.087 ± 0.003	0.063 ± 0.013	0.048 ± 0.014	0.393 ± 0.026
		3	0.038 ± 0.001	0.023 ± 0.003	0.071 ± 0.004	0.032 ± 0.004	0.066 ± 0.003	0.040 ± 0.007	0.041 ± 0.007	0.313 ± 0.021
		4	0.046 ± 0.001	0.031 ± 0.002	0.113 ± 0.008	0.04 ± 0.004	0.103 ± 0.004	0.072 ± 0.008	0.044 ± 0.0006	0.451 ± 0.025
	♀	1	0.080 ± 0.001	0.034 ± 0.001	0.169 ± 0.014	0.053 ± 0.0006	0.153 ± 0.004	0.123 ± 0.006	0.077 ± 0.007	0.691 ± 0.0237
		2	0.066 ± 0.002	0.032 ± 0.001	0.116 ± 0.007	0.044 ± 0.002	0.104 ± 0.002	0.077 ± 0.008	0.061 ± 0.006	0.502 ± 0.015
		3	0.050 ± 0.0008	0.038 ± 0.003	0.079 ± 0.015	0.032 ± 0.002	0.072 ± 0.003	0.055 ± 0.008	0.049 ± 0.008	0.377 ± 0.0245
		4	0.059 ± 0.0006	0.042 ± 0.003	0.147 ± 0.011	0.058 ± 0.006	0.111 ± 0.023	0.086 ± 0.028	0.074 ± 0.002	0.579 ± 0.058
Kollam	♂	1	0.057 ± 0.004	0.027 ± 0.002	0.121 ± 0.013	0.044 ± 0.006	0.125 ± 0.014	0.101 ± 0.020	0.064 ± 0.006	0.541 ± 0.056
		2	0.045 ± 0.002	0.027 ± 0.002	0.102 ± 0.008	0.033 ± 0.002	0.086 ± 0.007	0.067 ± 0.008	0.049 ± 0.006	0.411 ± 0.033
		3	0.040 ± 0.002	0.023 ± 0.001	0.087 ± 0.008	0.028 ± 0.001	0.064 ± 0.005	0.038 ± 0.006	0.042 ± 0.006	0.324 ± 0.020
		4	0.054 ± 0.006	0.027 ± 0.001	0.114 ± 0.017	0.050 ± 0.011	0.097 ± 0.008	0.075 ± 0.007	0.06 ± 0.007	0.479 ± 0.040
	♀	1	0.075 ± 0.002	0.043 ± 0.003	0.137 ± 0.012	0.069 ± 0.011	0.139 ± 0.006	0.115 ± 0.019	0.068 ± 0.012	0.649 ± 0.024
		2	0.065 ± 0.003	0.030 ± 0.001	0.095 ± 0.008	0.050 ± 0.006	0.102 ± 0.008	0.054 ± 0.004	0.049 ± 0.005	0.447 ± 0.021
		3	0.048 ± 0.001	0.032 ± 0.002	0.079 ± 0.010	0.050 ± 0.001	0.063 ± 0.003	0.050 ± 0.007	0.043 ± 0.005	0.367 ± 0.014
		4	0.065 ± 0.004	0.043 ± 0.003	0.134 ± 0.005	0.068 ± 0.005	0.118 ± 0.008	0.09 ± 0.005	0.061 ± 0.005	0.581 ± 0.016

The phylogenetic tree of the study specimen confirmed the similarity with the other voucher specimens of *S. sarasinorum* and shows a resemblance with the other social spider *S. mimosarum* and *S. dufouri* among the species of genus *Stegodyphus*. In 1989, Kraus & Kraus classified that *Stegodyphys pacificus* as sister species of *S. sarasinorum*. Because of the morphological resemblance of *S. pacificus* and *S. dufouri*, Kraus & Kraus (1990) considered these two species as geographical variants. Later Johannsenn *et al.* (2007) confirmed that *S. dufouri* is a sister species of *S. sarasinorum*.

The spider's morphology, behavioural tendencies and social demographics are determined by the social organization and colony demographics of the social spider colonies (Wright *et al.*, 2015). Fecundity selection is supposed to be driving the female-biased sexual size dimorphism in most insect orders (Horabin, 2005). And also (*a*) their size at hatching, (*b*) their rate of growth, (*c*) the duration of their growth period (Badyaev,

2002; Esperk *et al.*, 2007), and/or (*d*) size-dependent survival (Stillwell & Fox, 2007) also cause variation in sexual size dimorphism that occurs at the adult stage. The sexual size dimorphism of the Indian social spider studied in Kerala shows that it is highly female-biased. This large size variation in female spiders is highly correlated with the clutch size or fecundity in spiders (Prenter *et al.*, 1999).

Table 4. Evaluation of sexual size dimorphism of *S. sarasinorum* collected from Thrissur and Kollam districts of Kerala.

District	Size (cm) of the largest sex (Female)	Size (cm) of the smallest sex (Male)	SDI
Thrissur	0.786	0.44	1.786364
	0.74	0.48	1.541667
	0.654	0.445	1.469663
	0.766	0.432	1.773148
	0.751	0.452	1.661504
	0.681	0.41	1.660976
Kollam	0.615	0.47	1.308511
	0.593	0.451	1.314856
	0.631	0.44	1.434091
	0.72	0.42	1.714286
	0.69	0.41	1.682927
	0.62	0.43	1.441860

Conclusion

The findings of the study give more information to the existing knowledge regarding the distribution and structure of the Indian social spider *S. sarasinorum* found in Kerala. The colonies of this social spider are widely distributed in Kerala and are found to be located at an extremely low altitude. It shows close phylogenetic similarity with another social spider *S. mimosarum* and sister species *S. dufouri*. The morphological dissimilarity distinguishes male spiders from females easily.

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Buthus Leach, 1815 (Scorpiones: Buthidae): taxonomic status of species in Algeria with their morphological and molecular study in Aures region

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Abstract

The genus *Buthus* Leach, 1815 is the most diverse and the most widespread scorpion genus in family Buthidae C.L. Koch, 1837. In the last two decades, an impressive number of publications have demonstrated remarkable progress in the number of *Buthus* species in Algeria, which has risen to ten species. The taxonomic status of the genus based on morphologic keys, deserves to be elucidated with an exhaustive list of species as taxonomic reference including dichotomous keys and genetic barcodes.

In this paper, a genetic study of *Buthus* species complex from Aures region (eastern Algeria) has been performed based on DNA barcoding. In addition, a multi-rate Poisson tree process (mPTP) and Assemble Species by Automatic Partitioning (ASAP) methods were used to generate molecular species descriptions of 229 COI sequences. The morphological results lead to the description of two *Buthus* species in our study area: *Buthus aures* Lourenço & Sadine, 2016, and *Buthus tunetanus* (Herbst, 1800). Among the important results is the confirmation of the morphological identification of two Algerian

Buthus species (*B. aures* and *B. tunetanus*) by the genetic identity. Furthermore, 22 molecular operating taxonomic units (mOTUs) were suggested by mPTP method, where eight mOTUs are distributed all over Algeria, of which Aures region includes four of them. In addition, according to literature data, the number of existing *Buthus* species and their geographical distribution patterns in Algeria are discussed.

Keywords: *Buthus aures*, *Buthus tunetanus*, COI gene, Phylogeny, ASAP, mPTP, mOTU, Algeria.

Introduction

Scorpion fauna of Algeria is very ancient and original (Vachon, 1952; Cloudsley-Thompson, 1984) with a high level of endemism (Sadine *et al.,* 2020; Abidi *et al.,* 2021; Ythier *et al.,* 2021; Rein, 2022). The updating list of known Algerian scorpions refers to a total number of 49 species, 14 genera, and 3 families (Sadine *et al.,* 2020; Mekahlia *et al.,* 2021), whereas 86% of them belong to Family Buthidae (Sadine *et al.,* 2020).

Buthus Leach, 1815 is the second oldest valid genus in Order Scorpiones (Sousa *et al.,* 2017). In the last twenty years, an impressive number of publications attested to the remarkable progress in the number of species described in genus *Buthus* in Algeria (Lourenço, 2002, 2013; Sadine *et al.*, 2016; Lourenço & Sadine, 2016; Lourenço *et al.*, 2020; Abidi *et al.*, 2021; Ythier *et al.*, 2021), in which 10 species of the genus are validated (Ythier *et al.*, 2021). The rapid increase in the number of species in this genus may be complicated by the difficulty of morphological identification, showing a high degree of morphological plasticity (Vachon, 1952).

Historically, most of the existing literature is Vachon (1952), El-Hennawy (1992), Sadine *et al.* (2018) and other similar contributions to the Algerian scorpion fauna are based on morphological and morphometric studies. However, the phylogeny and DNA barcoding of identified species have never been investigated, except for some general attempts focusing on the Maghreb *Buthus* gene (Sousa *et al.*, 2012; Pedroso *et al.*, 2013; Klesser *et al.*, 2021).

Many authors have stated that morphotaxonomy is insufficient to cover the identity of most species and therefore the keywords used in taxonomy are uncertain (Lourenço, 2002; Sousa *et al.*, 2012; Pedroso *et al.*, 2013; Sousa *et al.*, 2017; Klesser *et al.*, 2021). Therefore, genetic studies have become essential to revise and to confirm many genera, including the genus *Buthus*.

This paper aims to combine morphometrical and genetic studies to precisely identify species of genus *Buthus* collected from Aures region (eastern Algeria), and to search for a possible relationship between sequences and different reported species of the genus, particularly those found in Algeria.

Material and Methods

Study area

This study was conducted in the south-eastern part of the Aures massif, which is located in the eastern part of the Algerian Saharan Atlas (Fig. 1). This massif forms a set of high, continuous, and powerful mountains, with very contrasting reliefs, ranging in elevation from 50 m to 2300 m (Besnier, 1899; Lafitte, 1939; Ballais & Ballais, 1989). Aures region is more affected by the Saharan climate, where the massifs of our study area on the southern slope of the Aures have more or less xerophilous vegetation with Saharan affinities (Desanges & Riser, 1989).

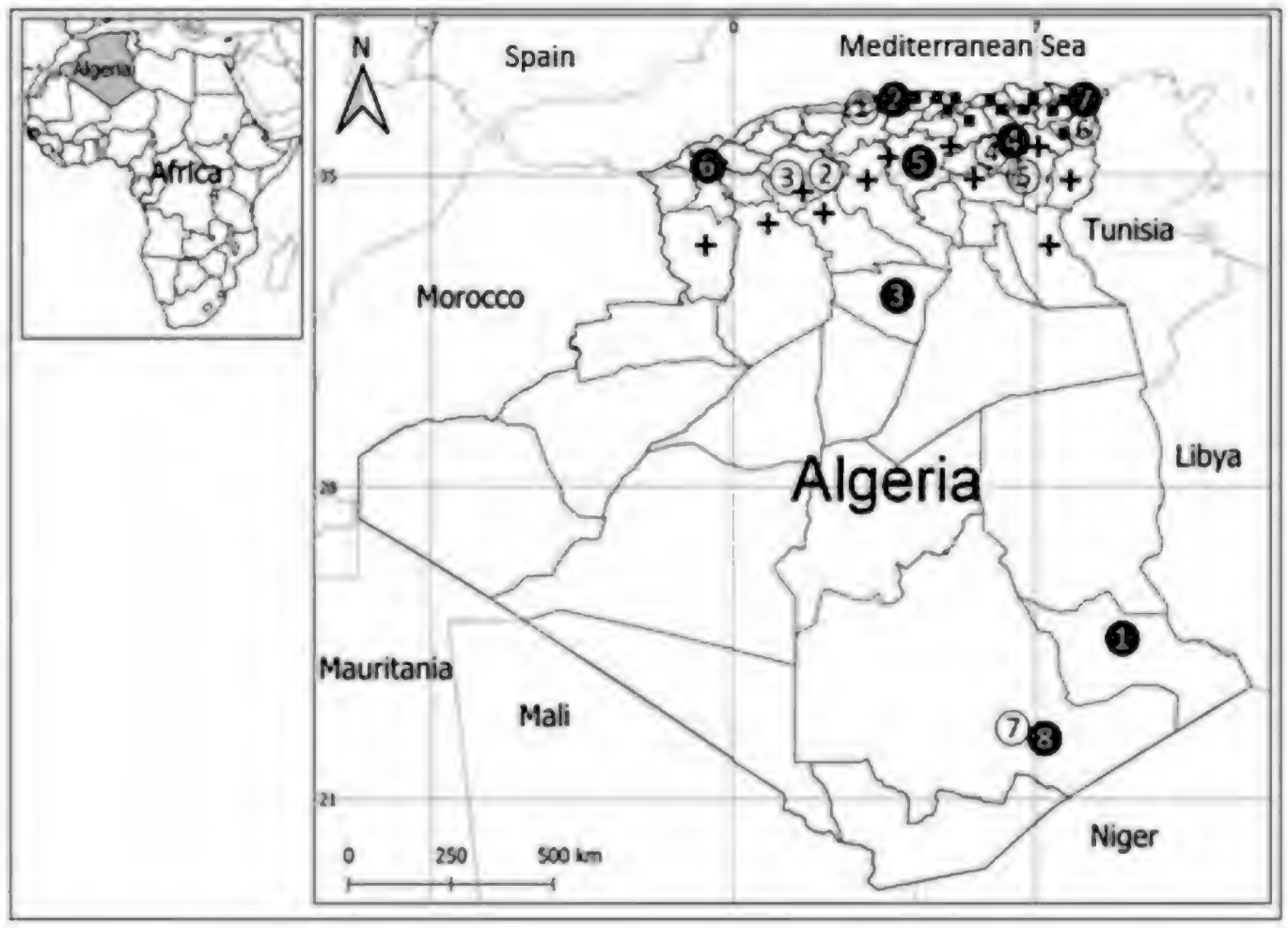

Fig. 1. Map of Algeria showing the distribution of *Buthus* species and DNA sequences.
Species distribution: (+) *B. tunetanus*, (▪) *B. paris*, (❶) *B. tassili*, (❷) *B. pusillus*, (❸) *B. saharicus*, (❹) *B. aures*, (❺) *B. boussaadi*, (❻) *B. apiatus*, (❼) *B. goyffoni*, (❽) *B. ahaggar*.
Sequences placements: (①) JQ775953, JQ775954; (②) JQ775955, KF824989; (③) JQ775959, KF824990; (④) JQ775958, KF824991, MT955916, MT955957, ALG1, ALG2, ALG3, ALG4, ALG5; (⑤) KF824988; (⑥) JN885952, JN885953; (⑦) MT955943, MT955944, MT955945.

Sampling and specimens identification

Scorpions were sampled from two sites: Aïn Beïda and Laksar (Table 1; Fig. 2). Our sampling field trips took place between 2018 to 2020, researching the scorpions under rocks during the day and using UV light at night.

Table 1. Characteristics of the two sampling sites.

Site	Geographic coordinates	Altitude (m)	Climate	Vegetation
Aïn Beïda	35°05'N, 06°23'E	1731	Semiarid	*Artemisia campestris* L. *Juniperus phoenicea* L.
Laksar	35°08'N, 06°18'E	1000	Arid	*Artemisia herba-alba* Asso *Juniperus phoenicea* L. *Opuntia ficus-indica* (L.) Mill. *Prunus armeniaca* L.

Collected specimens were individually conserved in absolute ethanol at -20°C where the date and the site of collection were noted. Morphological identification of the specimens was obtained using a stereomicroscope as described by Stahnke (1970) and Vachon (1974). In this study, only adult individuals were considered for identification. This material was deposited in the Laboratory of Genetic, biotechnology and valorisation of bioresources, University of Biskra, Algeria.

Fig. 2. Natural biotopes of the sampled scorpions. A. Aïn Beïda site. B. Laksar site.

Molecular Analysis

Genetic analyses were performed in the Molecular Biology Lab, Al-Azhar University, Assiut, Egypt. Using QIAamp DNA Mini and Blood Mini Handbook Kit (Qiagen) and following the manufacturer's instructions, whole genomic DNA was extracted from preserved (absolute ethanol) hand musculature of five morphometrically identified scorpions. Invertebrate universal primers LCO1490 and HCO2198 were used to amplify a fragment of COI gene using standard polymerase chain reaction (PCR) procedures as determined by Folmer *et al*. (1994).

PCR reaction was performed in 30 µL volumes consisting of 15 µL 2x Go Taq® Green Master Mix (Promega Corporation-Madison, WI, USA), 2.5 µL of each primer, 5 µL PCR grade water and 5 µL DNA template. The PCR conditions and primers sequence are shown in (Table2). PCR product was checked by gel electrophoresis. Purification of amplified products was performed using QIA quick PCR Purification Kit Protocol. A Big Dye Terminator Cycle Sequencing Ready Reaction Kitv.3.1 (Qiagen Inc., Valencia, CA, USA), with electrophoresis on an ABI 3500 automated sequencer (Applied Biosystems Inc., USA) was used to sequence the amplicons bidirectionally. The generated sequences are submitted in to GenBank data system.

Table 2. Thermal profile and primers sequence.

Step	Temperature	Time	
Initial Denaturation	95°C	5 min	
Denaturation	95°C	1 min	
Annealing	40°C	1 min	35 cycles
Extension	72°C	8 min	
LCO1490 (F)	5′ -GGTCAACAAATCATAAAGATATTGG-3′		
HCO2198 (R)	5′ -TAAACTTCAGGGTGACCAAAAAATCA-3′		

Data analysis

Samples were screened and analysed by Finch TV 1. 4. 0 (Geospiza, Inc., USA; http://www.geospiza.com). Then the nucleotides sequences of a fragment of COI gene were examined and searched for sequences similarity using nucleotide BLAST (https://www.ncbi.nlm.nih.gov/) and BOLD. We have performed MUSCL multiple sequence alignment (Edgar RC 2004) of our samples with 221 additional sequences of genus *Buthus* and three sequences as out-groups downloaded from BOLD (Ratnasingham & Hebert, 2007) and GenBank (Benson *et al.*, 2016) (Table 3) using MEGA version X (Kumar *et al.*, 2018), retaining the default settings. To analyse COI sequence data, Maximum Likelihood (ML) and Bayesian inference (BI) trees were reconstructed using

the new generation phylogenetic services for non-specialists server (NJGPhylogeny.fr) (Lemoine *et al.*, 2019). The consensus tree was edited through web based iTOL tool (https://itol.embl.de) (Letunic & Bork, 2019). In addition, species delimitation was performed using two methods: Multi-rate Poisson tree processes (mPTP) (Kapli *et al.*, 2017) and Assemble Species by Automatic Partitioning (ASAP) (Puillandre *et al.*, 2021) as a species delimitation tool to estimate the number of mOTUs and match morphological species identifications with genetic delimitations.

Table 3. GenBank accession numbers, Countries, Locations, Species, mOTUs by mPTP and mOTUs ABGD (in the study by Klesser *et al.*, 2021) of 28 sequences used in phylogenetic tree construction. * = Not included in the study of Klesser *et al.* (2021).

GenBank accession number	Country	Location	Species	mOTU mPTP	mOTU (Klesser *et al.*, 2021)
Alg 1	Algeria	Aïn Beïda	*Buthus tunetanus*	17	*
Alg 2		Laksar	*Buthus aures*	21	*
Alg 3		Laksar	*Buthus aures*	21	*
Alg 4		Aïn Beïda	*Buthus aures*	21	*
Alg 5		Laksar	*Buthus tunetanus*	17	*
AJ506916	Tunisia	Touzeur	same distribution of *Buthus tunetanus* (Sousa *et al.*, 2012)	17	Not studied
DQ127507	Outgroup	–	*Centruroides vittatus*	Outgroup	Outgroup
JF700145			*Olivierus martensii*		
KF997876			*Aegaeobuthus gibbosus*		
JN885952	Algeria	Oulad Driss	*Buthus boumalenii* (Klesser *et al.*, 2021)	2	18
JN885953				2	18
JQ775953		Tell Atlas	same distribution of *Buthus paris* (Sousa *et al.*, 2012)	22	*
JQ775954		Tell Atlas		22	12
JQ775955		Tell Atlas		21	1
JQ775958		Aures mts		17	10
JQ775959		Tell Atlas		1	13
KF824988		Chelia	*Buthus* sp.	17	*
KF824989		Ksar Chellala		21	*
KF824990		Rechaiga		21	*
KF824991		Parc National Belezma		21	*
MT955916		Ghassira		21	1
MT955934	Tunisia	Ain Draham		18	11
MT955935				18	11
MT955936				18	11
MT955943	Algeria	Hoggar	*Buthus tassili* (Klesser *et al.*, 2021)	5	15
MT955944				5	15
MT955945				5	15
MT955957		Ghassira	*Buthus* sp.	6	20

Results and Discussion

Morphometric study

Systematic analysis

During a period of three years (2018-2020), 300 scorpions of the genus *Buthus* in two selected sites were collected and examined. Only adult scorpions (68) were analysed. The morphological examination and morphometric measurements of the 68 individuals conduce to identify them as two morphospecies distributed in the two sampling sites: *Buthus aures* Lourenço & Sadine, 2016 and *Buthus tunetanus* (Herbst, 1800).

Buthus aures Lourenço & Sadine, 2016 was first described in Batna region from a forest formation at 1556 m altitude (Lourenço & Sadine, 2016). A few years later, it was found in Khanchela (Meddour *et al.*, 2017) and then in Tebessa (Abidi *et al.*, 2020; Mekahlia *et al.*, 2021). In our case, this species was captured during all seasons of the year from a mountainous formation where the altitude ranges from 1000 to 1700 m. With 50 individuals, *B. aures* seems to be the most abundant species with a rate of 73. 5 %.

Buthus tunetanus (Herbst, 1800) is a widespread species in Algeria (Vachon, 1952; Abidi *et al.*, 2021). It has been mentioned in Morocco, Algeria, Tunisia, and Libya (Touloun *et al.*, l999; Lourenço, 2002; Kovařík, 2006; Sousa *et al.*, 2017), occurring from Tunisia to Morocco in the central horizontal band between 31°N to 35°N (Vachon, 1952; Sadine *et al.*, 2012; Lourenço, 2013; Sadine *et al.*, 2016; Lourenço & Sadine, 2016; Sadine *et al.*, 2020; Lourenço *et al.*, 2020). It can extend also to the North of Algeria (Ouici *et al.*, 2020; Touati *et al.*, 2021). In our study, *B. tunetanus* is represented by 26.5% with 18 individuals.

Morphometric and morphological analysis

The morphometric and morphological values of the two studied species of *Buthus* are summarised in Fig. (3) and Table (4).

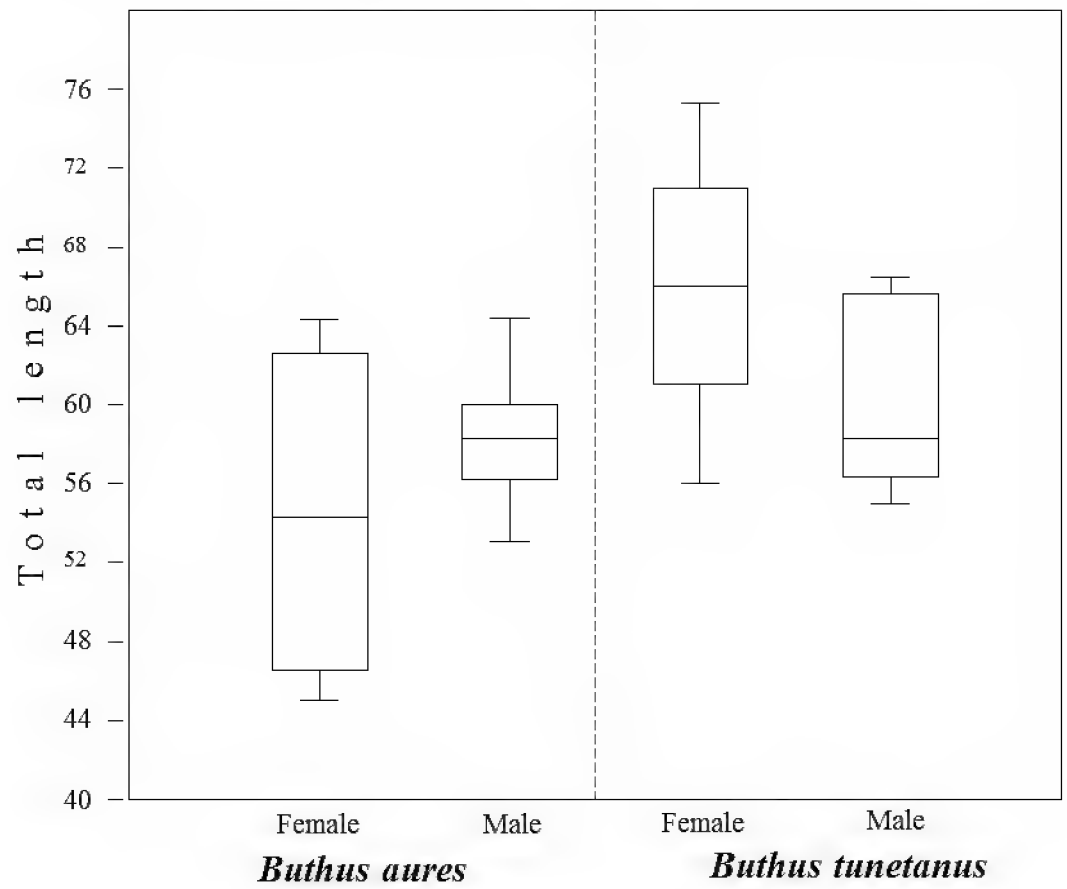

Fig. 3. Box plot summary of *Buthus* species sizes. Size information is available for 50 specimens of *B. aures* and 18 specimens of *B. Tunetanus*.

Table 4. Morphometric and morphological values of identified scorpions.

Species	Sex	Number	Number of rows in fingers	Pectinal teeth number												
				24	25	26	27	28	29	30	31	32	33	34	35	36
B. aures	♂	45	10/12; 11/12													
	♀	05														
B. tunetanus	♂	10	11/13; 12/13													
	♀	08														

Diagnostic of the adult body sizes (including telson) of 68 *Buthus* from Aures region (Fig. 3) showed that these sizes were ranged from 45 to 75 mm. *B. tunetanus* population showed a fairly large size compared to that of *B. aures* population. In contrast, males are smaller than females in both species. Vachon (1952) mentioned that the sizes of *Buthus* species exceeds 40 mm and can reach 11 mm. However, Sousa *et al.* (2017) showed that the sizes range from 38 to 90 mm, with a maximum size of 60-70 mm in females and 55-70 mm in males. Among the ten species of *Buthus* identified in Algeria (Ythier *et al.*, 2021), the biggest species is *B. boussaadi* Lourenço, Chichi & Sadine, 2018 with a size reaches 78 mm in female (Lourenço *et al.*, 2018) and in *B. paris* (C.L. Koch, 1839) the total length ranges from 60 to 75 mm in both females and males (Abidi *et al.*, 2021). However, *B. pusillus* Lourenço, 2013 appears to be the smallest *Buthus* in Algeria reaching a total length of 41 mm in males (Lourenço, 2013).

The values of two morphological meristic traits that can be used to identify scorpions are summarised in Table (4): number of rows of granules of movable and fixed fingers and the number of pectinal teeth. The number of rows of granules of the movable finger of the pedipalp chela seems to be stable among species: 12 rows in *B. aures* and 13 rows in *B. tunetanus*. In contrast, there is a slight variation in the fixed finger in both species. The number of rows in Algerian *Buthus* is very close (Lourenço, 2002; Lourenço, 2013; Sadine *et al.*, 2016; Lourenço & Sadine, 2016; Lourenço *et al.*, 2018; Lourenço *et al.*, 2020; Abidi *et al.*, 2021; Ythier *et al.*, 2021). However, Sousa *et al.* (2017) reported that this variation in the number of granule rows is not very informative.

Notably, pectinal teeth number in studied *Buthus* shows a significant variation for species as well as for sex. Females count from 24 to 30 teeth and males count from 23 to 36 teeth. We noted that *B. aures* has the highest number of pectinal teeth number in Algerian *Buthus* scorpions. The number of pectinal teeth in *B. paris* can reach from 29 to 34 teeth in male (Kovařík, 2006).

Phylogenetic study

We have successfully sequenced five mitochondrial cytochrome oxidase I (COI) of two morphometrically identified species with a total length of 478-694 bp.

BLAST and BOLD comparison showed the absence of accurate species-level barcodes for the assessed species. However, Alg1 and Alg5 showed important sequence similarity with sample collected from Chelia (KF824988) from the centre of Aures Mountains. Our specimens of *Buthus aures* species (Alg2, Alg3, and Alg4) showed maximum similarity with the specimens collected from Tiaret region (Tell Atlas) and Ghassira (Aures Mountains) (JQ775955, KF824989, and MT955916).

The MUSCL alignment of our sequences (Alg1, Alg2, Alg3, Alg4, Alg5) was performed with 221 additional sequences of the genus *Buthus* and three sequences as out-groups downloaded from BOLD and GenBank (Table 3). All these data allowed to construct a phylogenetic tree (Supplement material 1) which confirms the paraphyly of the genus *Buthus*. Also, ASAP, and mPTP servers are used as a species delimitation tool to estimate the number of mOTUs and match morphological species identification with

genetic delimitations. As a result, the ASAP Algorithm identified 27 mOTUs (Supplement material 2) while mPTP revealed 22 mOTUs which is used as the most conservative estimation for discussion where some mOTUs were fused or split compared to the 24 mOTUs that appeared in the study by Klesser *et al.* (2021). In contrast, the sequences from Algerian *Buthus* were repaired into eight mOTUs (1, 22, 5, 2, 18, 17, 6 and 21).

In the modified molecular phylogeny (Bayesian inference tree), clades from mOTUs that do not contain sequences from the Algerian specimens were deleted (Fig. 4). The mPTP method suggested eight mOTUs (1, 22, 5, 2, 18, 17, and 26), five of them (1, 5, 2, 18, and 6) with sequences were mentioned and arranged in mOTUs with the same order in the study of Klesser *et al.* (2021). The appearance of the sequences (JQ775959, JQ775953, and JQ775954) in two different clades was well supported by those partition in two mOTUs (1 and 22), of which, these sequences corresponded to specimens collected from North Algeria (Algiers) (Sousa *et al.*, 2012) which can coincide with the geographical coordinates of the species *Buthus paris* and *Buthus pussilus* (Fig. 1). The mOTU 5 contains sequences from scorpions collected from Southern Algeria (Hoggar Mountains) (MT955943, MT955944, and MT955945). This group can represent *Buthus tassili* Lourenço, 2002 which is distributed in Tassili N'ajer region (Klesser *et al.*, 2021) or *Buthus ahaggar* Ythier, Sadine, Haddadi & Lourenco, 2021 (newly described from the Hoggar Massif). According to Klesser and his collaborators (2021), the mOTU 2 was matched with *Buthus boumalenii* Touloun & Boumezzough, 2011. This species has never been reported before in Algerian *Buthus* species (Ythier *et al.*, 2021).

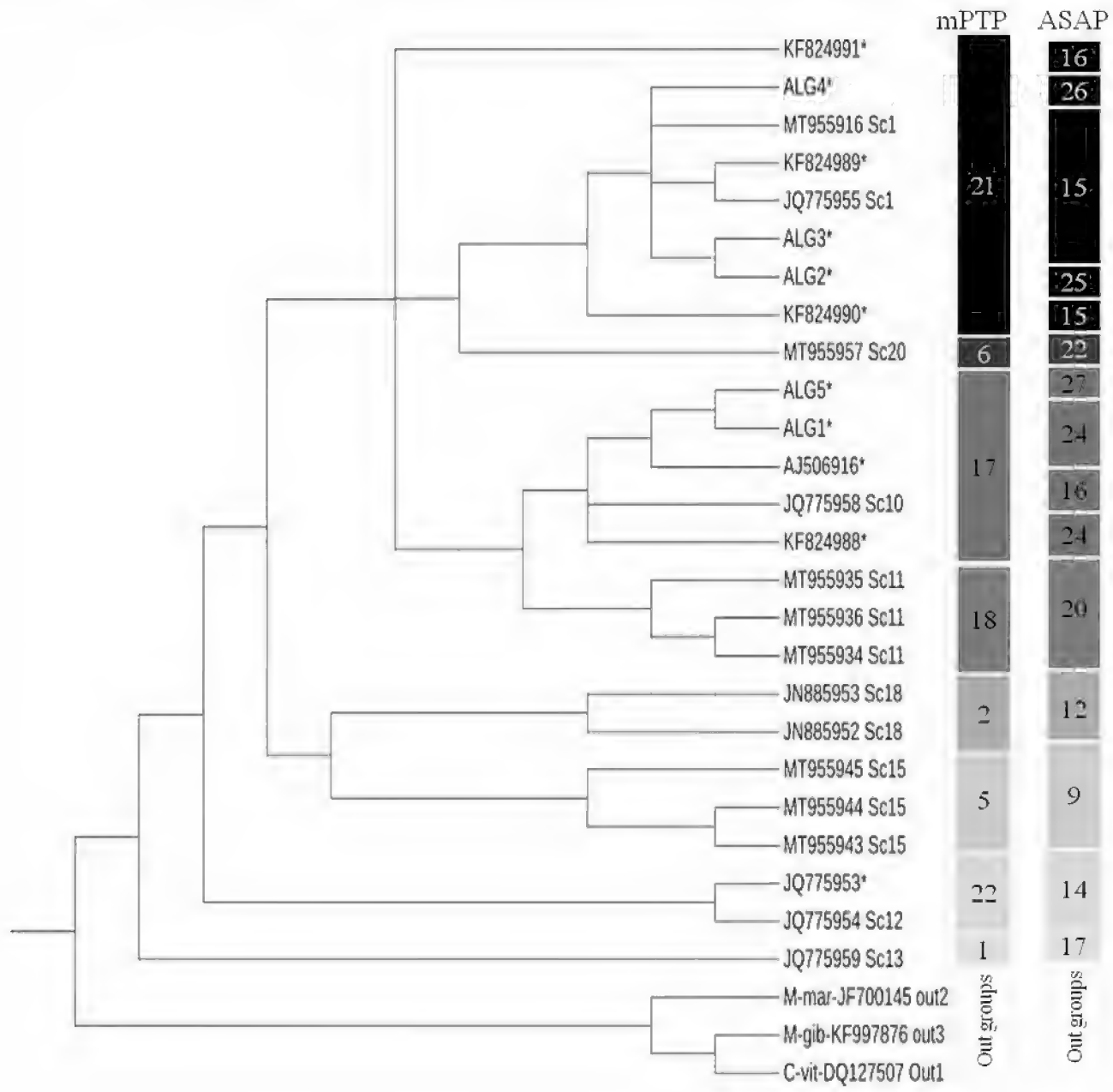

Fig. 4. Bayesian inference tree showing the position of Algerian *Buthus* species based on partial sequences of mtCOI (modified by following the global tree). Bars indicate molecular operational taxonomic units (mOTUs) derived from two different methods: mPTP and ASAP.

The sequences of Alg1 and Alg5 were morphologically identified as *Buthus tunetanus*. They are arranged in mOTU 17, where the specimen collected from Tozeur region (Tunisian Sahara) was the closest one (AJ506916). This specimen was identified as *Buthus tunetanus* (Gantenbein & Largiadèr, 2003) which confirms once again the geographical distribution of this species and reinforces our identification. The other sequences (JQ775958 and KF824988) were correspondent to specimens collected from the central Aures (Sousa *et al.*, 2012; Pedroso *et al.*, 2013). This group is ranked as a sister clad to the clad which includes three sequences (MT955934, MT955935, MT955936) (mOTU 18) that were sampled from Tell Atlas Mountains in Tunisia (Ain Draham) (Klesser *et al.*, 2021). This result shows that *Buthus tunetanus* occupies a large area from the Tellian Atlas through the Saharan Atlas to the beginning of the northern Sahara (Vachon, 1952; Gantenbein & Largiadèr, 2003; Kovařík, 2006; Sadine *et al.*, 2018; Ouici *et al.*, 2020). Furthermore, the distribution of these sequences into two subclades is confirmed by Klesser *et al.* (2021). The presence of these subclades in two different mOTUs (Motu11 and mOTU10 respectively) indicates the possibility of the existence of a cryptic taxon.

The mOTU 6 with mono sequence MT955957 from *Buthus* of Ghassira region probably represents supplement taxa in addition to the identified *Buthus* in Aures region.

The mOTU 6 comprises a single sequence MT955957 from sample collected from Ghassira region (about 15 km away from our study area) probably represents a supplement taxon in addition to the identified *Buthus* species in Aures region.

The sequences Alg2, Alg3, Alg4 morphologically identified as *Buthus aures* belonged to the mOTU 21 with other 5 sequences; KF824991 and MT955916 from the southern part of Aures Mountain (Pedroso *et al.*, 2013; Klesser *et al.*, 2021) and JQ775955, KF824989, and KF824990 sampled from geographical area (high steppe plains) not very far from the natural habitat of *Buthus aures* species (Sousa *et al.*, 2012; Pedroso *et al.*, 2013). This result probably indicates that *Buthus aures* occurring on a larger geographical scale and greatly expanding its distribution to reach a medium altitude (800 m and 1000 m) and the climate ranges to the semiarid.

Conclusion

This work constitutes the first study that combines between the morphometric, the phylogenetic, and the species delimitation of two *Buthus* species from Aures region in North Africa. The morphological authentication was well supported by the phylogeny and species delimitation results (mPTP), in which the two morphospecies were situated in two separate clades and mOTUs. The phylogenetic and geographical data showed the presence of same genetic lineage in Aures region (Batna, Khanchela, and Tebessa) and in a high steppe (Tiaret). A possible new record of an endemic Moroccan species; *Buthus boumalenii* Touloun & Boumezzough, 2011 in Algeria is expected. Furthermore, mPTP results showed very important scorpion diversity in Aures region which may contain at least four *Buthus* species. Finally, further study in larger territories and with a greater number of samples is in preparation.

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(Supplement material 1)
(Supplement material 2)

Supp material 1: Bayesian Inference tree of the Mediterranean Buthus species developed on COI gene. For each sequence, accession number and mOTU (SC in the study of Klasser et al. 2021) are given. (*) Shows the sequences newly analysed (ALG1, ALG2, ALG3, ALG4, and ALG5) and those which are not incorporated in the study of Klasser et al. (2021).

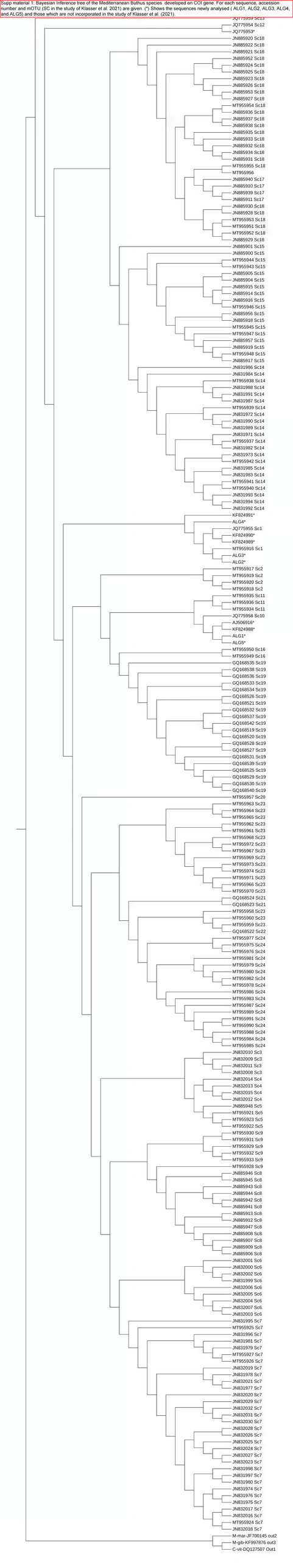

Figure S2: The following figures show the results of the species delimitation tools. We analyzed our data set using Multi-rate Poisson tree processes (mPTP) (Kapli et al. 2017) and Assemble Species by Automatic Partitioning (ASAP) (Puillandre et al. 2021) method.

Results from Multi-rate Poisson tree processes -mPTP

Species 1:
JQ775959_Sc13

Species 2:
JN885920_Sc18
JN885922_Sc18
JN885921_Sc18
JN885935_Sc18
JN885932_Sc18
JN885931_Sc18
JN885934_Sc18
JN885933_Sc18
JN885936_Sc18
MT955954_Sc18
JN885938_Sc18
JN885937_Sc18
JN885940_Sc17
JN885910_Sc17
JN885911_Sc17
JN885939_Sc17
MT955956
MT955955_Sc18
JN885928_Sc18
JN885930_Sc18
MT955951_Sc18
MT955953_Sc18
JN885929_Sc18
MT955952_Sc18
JN885923_Sc18
JN885927_Sc18
JN885953_Sc18
JN885926_Sc18
JN885952_Sc18
JN885925_Sc18
JN885924_Sc18

Species 3:
JN885901_Sc15

Species 4:
JN831986_Sc14
JN831984_Sc14
JN831983_Sc14
JN831985_Sc14
JN831993_Sc14
JN831992_Sc14
JN831994_Sc14
MT955940_Sc14
MT955941_Sc14
MT955942_Sc14
JN831973_Sc14
JN831982_Sc14
MT955937_Sc14
JN831971_Sc14
MT955939_Sc14
JN831989_Sc14
JN831990_Sc14
JN831972_Sc14
JN831988_Sc14
JN831987_Sc14
JN831991_Sc14
MT955938_Sc14

Species 5:
MT955943_Sc15
MT955944_Sc15
JN885918_Sc15
JN885956_Sc15
MT955945_Sc15
JN885957_Sc15
JN885919_Sc15
JN885917_Sc15
MT955948_Sc15
MT955947_Sc15
JN885904_Sc15
JN885905_Sc15
JN885914_Sc15
JN885915_Sc15
MT955946_Sc15
JN885916_Sc15
JN885900_Sc15

Species 6:
MT955957_Sc20

Species 7:
JN831995_Sc7
MT955925_Sc7
JN832019_Sc7
JN831978_Sc7
JN831977_Sc7
JN832021_Sc7
JN832029_Sc7
JN832032_Sc7
JN832030_Sc7
JN832031_Sc7
JN831974_Sc7
JN831975_Sc7
JN831976_Sc7
JN832016_Sc7
JN832017_Sc7
JN832018_Sc7
MT955924_Sc7
JN831980_Sc7
JN831997_Sc7
JN831998_Sc7
JN832026_Sc7
JN832028_Sc7
JN832025_Sc7
JN832024_Sc7
JN832023_Sc7
JN832027_Sc7
JN832020_Sc7
JN831996_Sc7
JN831981_Sc7
JN831979_Sc7
MT955926_Sc7
MT955927_Sc7

Species 8:
JN832006_Sc6
JN832005_Sc6
JN832004_Sc6
JN832003_Sc6
JN832007_Sc6
JN832001_Sc6
JN832000_Sc6
JN831999_Sc6
JN832002_Sc6

Species 9:
MT955929_Sc9
MT955933_Sc9
MT955932_Sc9
MT955931_Sc9
MT955930_Sc9
MT955928_Sc9
JN885945_Sc8
JN885946_Sc8
JN885912_Sc8
JN885913_Sc8
JN885947_Sc8
JN885907_Sc8
JN885906_Sc8
JN885909_Sc8
JN885908_Sc8
JN885943_Sc8
JN885941_Sc8
JN885942_Sc8
JN885944_Sc8

Species 10:
JN832010_Sc3
JN832009_Sc3
JN832008_Sc3
JN832011_Sc3

Species 11:
JN832014_Sc4
JN832013_Sc4
JN832012_Sc4
JN832015_Sc4

Species 12:
JN885948_Sc5
MT955922_Sc5
MT955923_Sc5
MT955921_Sc5

Species 13:
MT955977_Sc24
MT955976_Sc24
MT955975_Sc24
MT955981_Sc24
MT955979_Sc24
MT955978_Sc24
MT955982_Sc24
MT955980_Sc24
MT955986_Sc24
MT955983_Sc24
MT955987_Sc24
MT955989_Sc24
MT955990_Sc24
MT955991_Sc24
MT955988_Sc24
MT955985_Sc24
MT955984_Sc24
MT955958_Sc23
MT955960_Sc23
GQ168522_Sc22
MT955959_Sc23

Species 14:
GQ168523_Sc21
GQ168524_Sc21

Species 15:
MT955961_Sc23
MT955962_Sc23
MT955968_Sc23
MT955967_Sc23
MT955972_Sc23
MT955969_Sc23
MT955971_Sc23
MT955970_Sc23
MT955966_Sc23
MT955974_Sc23
MT955973_Sc23
MT955963_Sc23
MT955965_Sc23
MT955964_Sc23

Species 16:
MT955917_Sc2
MT955919_Sc2
MT955918_Sc2
MT955920_Sc2

Species 17:
JQ775958_Sc10
KF824988*
AJ506916*
ALG5*
ALG1*

Species 18:
MT955935_Sc11
MT955934_Sc11
MT955936_Sc11

Species 19:
MT955949_Sc16
MT955950_Sc16

Species 20:
GQ168535_Sc19
GQ168536_Sc19
GQ168538_Sc19
GQ168521_Sc19
GQ168526_Sc19
GQ168527_Sc19
GQ168528_Sc19
GQ168531_Sc19
GQ168539_Sc19
GQ168525_Sc19
GQ168529_Sc19
GQ168540_Sc19
GQ168530_Sc19
GQ168542_Sc19
GQ168520_Sc19
GQ168519_Sc19
GQ168537_Sc19
GQ168532_Sc19
GQ168534_Sc19
GQ168533_Sc19

Species 21:
KF824991*
ALG4*
JQ775955_Sc1
KF824989*
KF824990*
MT955916_Sc1
ALG2*
ALG3*

Species 22:
JQ775953*
JQ775954_Sc12

Results from Assemble Species by Automatic Partitioning -ASAP)

Partition 5
Score: 5
Proba: 7.045908e-01
nb groups:27 (26)

Group[1] n: 20 ;id: GQ168519_Sc19 GQ168520_Sc19 GQ168532_Sc19 GQ168537_Sc19 GQ168542_Sc19 GQ168525_Sc19 GQ168527_Sc19 GQ168528_Sc19 GQ168539_Sc19 GQ168531_Sc19 GQ168529_Sc19 GQ168530_Sc19 GQ168540_Sc19 GQ168533_Sc19 GQ168534_Sc19 GQ168535_Sc19 GQ168536_Sc19 GQ168538_Sc19 GQ168521_Sc19 GQ168526_Sc19
Group[2] n: 1 ;id: GQ168522_Sc22
Group[3] n: 2 ;id: GQ168523_Sc21 GQ168524_Sc21
Group[4] n: 22 ;id: JN831971_Sc14 JN831972_Sc14 JN831973_Sc14 JN831992_Sc14 JN831993_Sc14 JN831994_Sc14 MT955942_Sc14 JN831983_Sc14 JN831985_Sc14 MT955940_Sc14 MT955941_Sc14 JN831982_Sc14 MT955937_Sc14 JN831984_Sc14 MT955938_Sc14 JN831986_Sc14 JN831987_Sc14 JN831988_Sc14 JN831991_Sc14 MT955939_Sc14 JN831989_Sc14 JN831990_Sc14
Group[5] n: 32 ;id: JN831974_Sc7 JN831975_Sc7 JN831976_Sc7 JN832016_Sc7 JN832017_Sc7 JN832018_Sc7 MT955924_Sc7 JN831980_Sc7 JN831997_Sc7 JN831998_Sc7 JN832023_Sc7 JN832024_Sc7 JN832025_Sc7 JN832027_Sc7 JN832026_Sc7 JN832028_Sc7 JN831977_Sc7 JN831978_Sc7 JN832019_Sc7 JN832021_Sc7 JN831979_Sc7 JN831981_Sc7 MT955926_Sc7 MT955927_Sc7 JN832020_Sc7 JN831996_Sc7 MT955925_Sc7 JN831995_Sc7 JN832029_Sc7 JN832030_Sc7 JN832031_Sc7 JN832032_Sc7
Group[6] n: 9 ;id: JN831999_Sc6 JN832000_Sc6 JN832001_Sc6 JN832002_Sc6 JN832003_Sc6 JN832005_Sc6 JN832007_Sc6 JN832006_Sc6 JN832004_Sc6
Group[7] n: 4 ;id: JN832008_Sc3 JN832011_Sc3 JN832009_Sc3 JN832010_Sc3
Group[8] n: 4 ;id: JN832012_Sc4 JN832013_Sc4 JN832014_Sc4 JN832015_Sc4
Group[9] n: 18 ;id: MT955943_Sc15 MT955944_Sc15 MT955945_Sc15 JN885900_Sc15 JN885904_Sc15 JN885905_Sc15 JN885917_Sc15 JN885919_Sc15 JN885957_Sc15 MT955947_Sc15 MT955948_Sc15 JN885918_Sc15 JN885956_Sc15 JN885914_Sc15 JN885915_Sc15 JN885916_Sc15 MT955946_Sc15 JN885901_Sc15
Group[10] n: 13 ;id: JN885906_Sc8 JN885907_Sc8 JN885909_Sc8 JN885908_Sc8 JN885947_Sc8 JN885941_Sc8 JN885942_Sc8 JN885944_Sc8 JN885943_Sc8 JN885912_Sc8 JN885913_Sc8 JN885945_Sc8 JN885946_Sc8
Group[11] n: 4 ;id: JN885910_Sc17 JN885911_Sc17 JN885939_Sc17 JN885940_Sc17
Group[12] n: 27 ;id: JN885952_Sc18 JN885953_Sc18 JN885920_Sc18 JN885921_Sc18 JN885922_Sc18 JN885928_Sc18 MT955952_Sc18 MT955953_Sc18 JN885930_Sc18 MT955951_Sc18 JN885931_Sc18 JN885932_Sc18 JN885933_Sc18 JN885934_Sc18 JN885938_Sc18 JN885935_Sc18 JN885937_Sc18 JN885929_Sc18 JN885936_Sc18 MT955954_Sc18 MT955955_Sc18 MT955956 JN885923_Sc18 JN885926_Sc18 JN885927_Sc18 JN885924_Sc18 JN885925_Sc18
Group[13] n: 4 ;id: JN885948_Sc5 MT955921_Sc5 MT955922_Sc5 MT955923_Sc5
Group[14] n: 2 ;id: JQ775954_Sc12 JQ775953*
Group[15] n: 5 ;id: JQ775955_Sc1 MT955916_Sc1 ALG3* KF824989* KF824990*
Group[16] n: 2 ;id: JQ775958_Sc10 KF824991*
Group[17] n: 1 ;id: JQ775959_Sc13
Group[18] n: 4 ;id: MT955917_Sc2 MT955918_Sc2 MT955919_Sc2 MT955920_Sc2

Group[19] n: 6 ;id: MT955928_Sc9 MT955929_Sc9 MT955930_Sc9 MT955932_Sc9 MT955933_Sc9 MT955931_Sc9
Group[20] n: 3 ;id: MT955934_Sc11 MT955935_Sc11 MT955936_Sc11
Group[21] n: 2 ;id: MT955949_Sc16 MT955950_Sc16
Group[22] n: 1 ;id: MT955957_Sc20
Group[23] n: 34 ;id: MT955958_Sc23 MT955959_Sc23 MT955960_Sc23 MT955961_Sc23 MT955962_Sc23 MT955963_Sc23 MT955967_Sc23 MT955972_Sc23 MT955968_Sc23 MT955973_Sc23 MT955974_Sc23 MT955969_Sc23 MT955970_Sc23 MT955971_Sc23 MT955966_Sc23 MT955964_Sc23 MT955965_Sc23 MT955975_Sc24 MT955976_Sc24 MT955977_Sc24 MT955978_Sc24 MT955979_Sc24 MT955980_Sc24 MT955982_Sc24 MT955981_Sc24 MT955983_Sc24 MT955984_Sc24 MT955985_Sc24 MT955988_Sc24 MT955989_Sc24 MT955987_Sc24 MT955990_Sc24 MT955991_Sc24 MT955986_Sc24
Group[24] n: 3 ;id: ALG1* KF824988* AJ506916*
Group[25] n: 1 ;id: ALG2*
Group[26] n: 1 ;id: ALG4*
Group[27] n: 1 ;id: ALG5*

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Mesiotelus tenuissimus (Araneae: Liocranidae) and the first record of its family in Jordan

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Abstract

Mesiotelus tenuissimus (L. Koch, 1866) of family Liocranidae is recorded from Jordan for the first time. Only one male specimen of this species was collected in October 2013 inside a house in Amman, Jordan. This is the first record of family Liocranidae too.

Keywords: Araneae, Liocranidae, *Mesiotelus tenuissimus*, Jordan.

Introduction

Genus *Mesiotelus* Simon, 1897 is one of the small genera of family Liocranidae Simon, 1897 which includes 309 species in 35 genera. The valid species of genus *Mesiotelus* are 16 species; they are distributed in: Europe (Portugal, Italy, North Macedonia, Bulgaria, Albania, Greece), Mediterranean (North Africa, Egypt, Lebanon, Cyprus, Turkey), Canary Is., Madeira, Kenya, Armenia, Azerbaijan, Iran, Turkmenistan, Central Asia, China (World Spider Catalog, 2022).

Its type species is *Mesiotelus tenuissimus* (L. Koch, 1866) which is recorded from Circum-Mediterranean: Portugal, Spain, France, Italy, Malta, Albania, Croatia, FYR Macedonia, Bulgaria, Greece, Turkey, Palestine/Israel, Yemen, Turkmenistan, Egypt, Libya, Tunisia, Algeria, Morocco (Bosmans & El-Hennawy, 2018).

The studied specimen is an adult male *Mesiotelus tenuissimus* (L. Koch, 1866) found moving, at night, on the ground inside a house in Abu Nseir, north of Amman, Jordan on 21st October 2013. Abu Nseir is one of the areas of the Greater Amman Municipality, Jordan. The house, "Qumei's house", has a small garden full of flowers (Fig. 1) that attracts different kinds of insects and their predators including spiders. Some spiders enter the house looking for prey or shelter or, maybe, for an arachnologist!

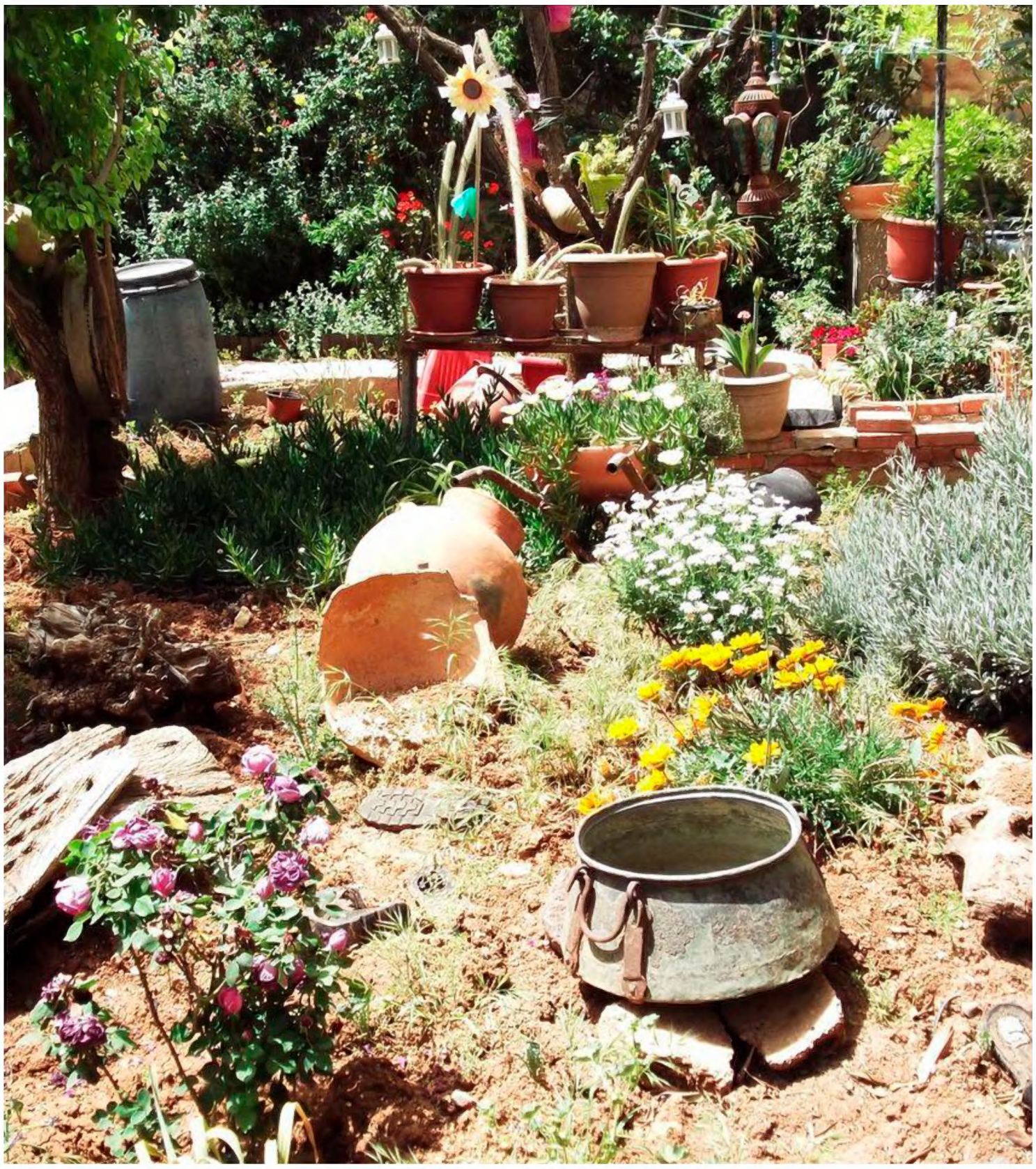

Fig. 1. Photograph of the garden of the house where the studied male *Mesiotelus tenuissimus* was found (Recent photo in April 2022).

Taxonomic references (+ localities)

Clubiona virgulata Blackwall, 1859: 257 (D♀; nomen oblitum). - Madeira

Cheiracanthium tenuissimum L. Koch, 1866: 237, pl. 9, f. 154 (D♂). - Dalmatia, Greece (Naxos), Algeria.

Liocranum cerioi Pavesi, 1875: 122 (D♂♀). - Italy (Capri).

Drassus spinulosus Thorell, 1875a: 98 (D♀); Thorell, 1875b: 96 (D♀). - Italia septentr. (Patavium).

Liocranum tenuissimum Simon, 1878: 295 (♂♀)Vaucluse ! -- Basses-Alpes: Digne ! Manosque ! -- Var : Hyères (A Grouvelle). -- Pyrénées-Orientales: Collioure ! Vernet (M. Nou).-- Corse !; Chyzer & Kulczyński, 1897: 242, pl. 9, f. 75 (♀).- Hungary (Buccari = Bakar, Croatia).

Liocranum spinulosum Simon, 1878: 297 (D♀). - Var: Les Arcs (Sédillot).

Agroeca cerioi Simon, 1878: 311. - Italy (Capri).

Liocranum alexandrinum Simon, 1880: 99 (D♀). - Egypt, Edko, near Alexandria.

Mesiotelus alexandrinus Roewer, 1955: 566. - Aegypten.

Mesiotelus tenuissimus Simon, 1897: 143, f. 144 (♂) - Regio mediterranea; Asia centr. et orientalis.; Simon, 1932: 939, 970, f. 1438-1439 (♂♀) - toute la région méditerranéenne. Midi de la France et Corse. -- Italie: ile Giglio (Doria). Dalmatie. Grèce.; Brignoli & Gaddini, 1979: 11, f. 1, 4 (♂♀) - Italy (several localities).; Barrientos & Urones, 1985: 354, f. 3a-b (♀) - Spain (Pradochano).; Mikhailov & Fet, 1986: 173, f. 1 (♂♀) - USSR. Turkmenistan, Central Asia; Kovblyuk *et al.*, 2008: 19, f. 6-12 (♂♀) - Ukraine (Crimea).; Bosmans *et al.*, 2009: 35, f. 24-28 (♂♀) - Greece (Lesbos).; Bosmans & El-Hennawy, 2018: 101, f. 1a-f, 2a-e (♂♀, S of *M. alexandrinus*). - Egypt (several localities).

Family **Liocranidae** Simon, 1897
Genus ***Mesiotelus*** Simon, 1897
Mesiotelus tenuissimus (L. Koch, 1866) (Figs. 2-5)

Material examined. Jordan, 1♂ (Fig. 2), Abu Nseir, north of Amman (32°03'17.4"N, 35°52'57.3"E elev. 1026 m), 21 October 2013 (11: 30 pm), moving on the ground inside a house, leg. Hisham K. El-Hennawy [ACE.2013.10.21.AR.001.JOR].

Measurements (in millimetres):
Total length 4.79; Cephalothorax length 2.37, width 1.87; Abdomen length 2.58.

Palp and palpal organ: prolateral view (Fig. 3), retrolateral view (Figs. 4-5).

Fig. 2. *Mesiotelus tenuissimus* (L. Koch, 1866) ♂. Habitus, dorsal view.

3

4

5

Figs. 3-5. *Mesiotelus tenuissimus* (L. Koch, 1866) ♂, palp. 3. prolateral view. 4-5. retrolateral view.

With this new record, and after the record of *Micrommata formosa* Pavesi, 1878 of family Sparassidae (El-Hennawy & Al-Saraireh, 2021), the list of spiders of Jordan (El-Hennawy, 2020) is expanded to include 15 families, 26 genera, and 30 species. More records are expected.

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